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Cultivating Paddy Rice in Trinidad

VOLUME 5, No. 5 MAY 1953

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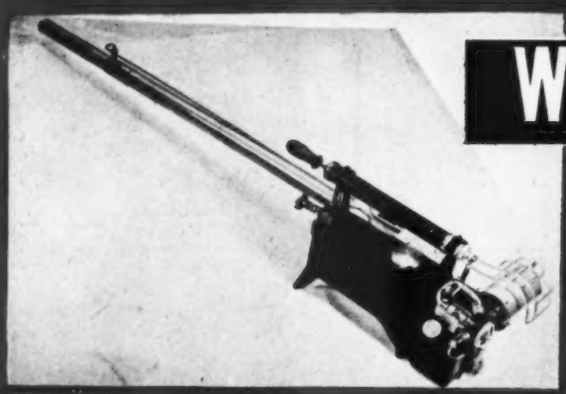

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WORLD CROPS

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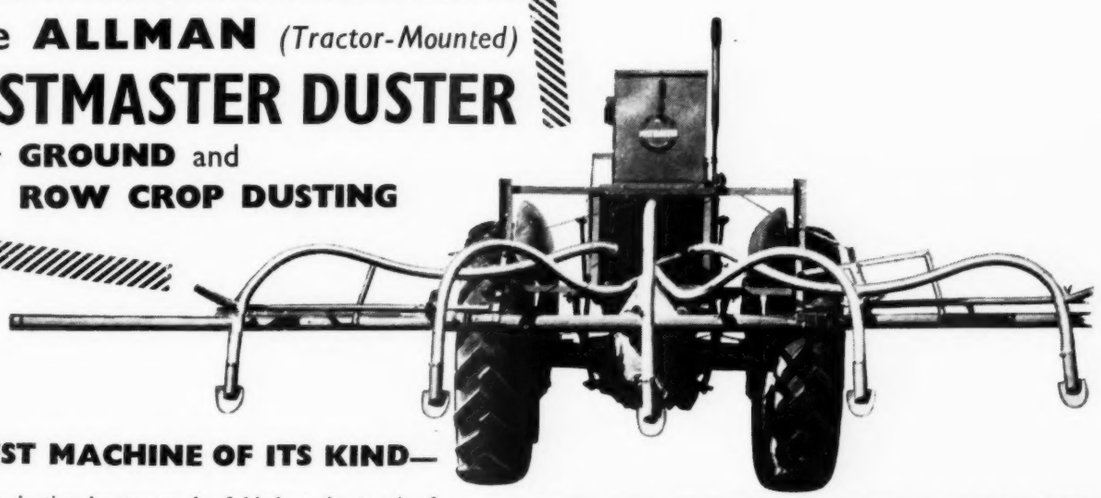

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Editorial Comment

The rise of rubber

IN the current issue of WORLD CROPS a number of articles appear which deal with various aspects of the rubber industry. Rubber is unique among tropical plantation crops in that it represents the outstanding example of a crop plant domesticated from a wild condition and built up into a great industry well within the memory of middle-aged people. It was only in the early years of the present century that plantation rubber began the phenomenal and sensational developments which culminate today in the annual production of close on 2,000,000 tons of natural rubber, 87% of which is grown on plantations and smallholdings in the Far Eastern countries of Malaya, Indonesia, Ceylon and Thailand.

Nearly all of this is the product of the tree *Hevea brasiliensis*, a native of the jungles of the Amazon, the many other trees and shrubs which also produce rubber having been outdistanced and outyielded by this particular plant.

It is indeed a far cry from the adventures of the intrepid and heroic Sir Henry Wickham, who at the behest of the authorities of Kew Gardens in 1876, and despite the opposition of the Brazilian Government, smuggled out of Brazil in a small steamer, which he had chartered, a cargo of rubber seed collected in the forests of the Amazon jungle. Only about 3,000 seeds survived the voyage, were raised as plants by the Kew authorities and established in Ceylon and Malaya. From them arose the millions of trees which make up the plantations of the East.

A few of these original importations still survive at Heneratgoda in Ceylon and Kuala Kangsar in Malaya. How much longer they can last is uncertain, for the actual length of life of a rubber tree is entirely conjectural, although the economic life has been placed by some authorities at between 30 and 40 years. Be this as it may, however, certainly these veterans, so long as they continue to exist, deserve to be ranked among the historic trees of the world.

Rubber and research

THIS rapid rate of development certainly could not have been achieved had there not been available from the outset scientific knowledge and experience which could be applied to the solution of the almost innumerable problems with which the infant industry was confronted.

Indeed, the inception of the industry was largely due to a scientific man in the person of H. N. Ridley, C.M.G., F.R.S., then in charge of the Botanic Gardens, Singapore, where the original seedlings from Kew were first planted out. Ridley remarked on the vigour with which the plants adapted themselves to their new environment, established trials in other parts of the Malay peninsula and began his long advocacy of the development of rubber planting as a commercial cultivation, in spite of opposition.

It was the development of the motor car which gave the necessary stimulus by reason of the demand it created for rubber for tyres, which existing supplies, in those days coming almost entirely from wild trees in Brazil and other countries, were powerless to satisfy.

It is of interest to record that Ridley is still living in retirement in this country and is rapidly nearing his hundredth birthday. He was rewarded for his services by the award of the C.M.G. by H.M. the King and was elected a Fellow of the Royal Society.

Meantime, vast fortunes have been made and lost as the result of the development of the industry which he did so much to initiate.

Solving the problems

IN the development of the industry science throughout has played a prominent part. At the outset there was everything to be found out and practically no information to go upon. Systems of tapping to extract the rubber had to be devised. The South American Indians who tapped the forest trees in Brazil did so by means of undiscriminating slashes with a machete, a method which was wasteful and resulted in the early death of the tree. Methods had to be devised of extracting the rubber from latex; pests and diseases of the tree made their appearance and means of combating them had to be devised; systems of cultivation had to be evolved. In due time all these difficulties were overcome, not without, let it be said, a good deal of acrimonious controversy at the time.

For example, the writer well remembers how in those days he was privileged to listen to learned controversies about a mysterious property, termed nerve, which the wild rubber from Brazil was alleged to possess and which was supposed to be lacking from the plantation product, to its alleged great detriment.

These are all things of the past and much that was then obscure has since been made clear. It is, however, as well to remember the names of some of the scientific workers who were responsible for elucidating these mysteries, such as Eaton, Sharples and Belgrave in Malaya, Petch, Willis and Parkin in Ceylon and, somewhat later, Maas, Bobbiloff and Heusser in Indonesia, to name but a few.

Throughout the history of rubber cultivation research has played a prominent part, and on research the plantation industry continues to rely in its struggle to compete with synthetic rubber substitutes. The foundation of the Rubber Research Institutes in Ceylon, Malaya and Java were noteworthy events; that in Malaya is one of the best housed, staffed and equipped research institutes overseas. Another important step was the establishment of research facilities in Europe and the setting up of an International Rubber Research Board with interconnections between the British, Dutch and French sections of the plantation industry, as well as maintaining close touch with research on the consumption side.

By reliance on research the plantation industry aims at meeting the threat from synthetic substitutes. Who shall say that this trust is misplaced and that in due course the plantation industry has not fair hopes of being able to live in peaceful competition with its synthetic sister?

After the floods

AN opportunity was afforded us recently of visiting a section of the flooded areas on the east coast of England, namely, the low-lying and extremely fertile corn and grazing lands of south-east Essex. For this county as a whole the total area flooded was, according to latest estimates, 49,000 acres, of which 41,000 acres are farmland. Breaking this figure down further, nearly 18,000 of these are arable acres, including about 7,000 acres of winter corn.

The visit, which was made by the Guild of Agricultural Journalists as guests of the Essex branch of the National Farmers' Union, took us along the Rivers Roach and Crouch between Foulness, Wallasea and Potton islands, all of which were inundated on the night of January 31, when the sea swept inland. Now, five weeks later, we saw something of the damage caused by the sea water which had lain over the fields, in some cases, for weeks; at the time of the visit about a quarter of the affected acreage was still under water.

One example

ON the 1,000-acre Potton Island, for example, there had been 270 acres of wheat grown for seed and 30 acres of oats grown for fodder (land, incidentally, capable of producing over 30 cwt. grain per acre), all of which now present a grey and desolate sight to the visitor, with the exception of two tiny and heavily contrasting patches of bright green where the water did not lap over. The remaining 700 acres of this island consist of grass leys, capable of fattening a bullock to the acre, and these, too, were covered by 6 to 8 in. of salt water. The man who farms this island, Mr. Harold Philpot, managed with the help of his men to swim all but 12 of the 400 ewes and tegs which were on the island at the time to safety on the mainland, and thence to his 400-acre farm inland. But it seems likely that three or four years will elapse before Potton Island can be cropped again, although it may be possible to get some sort of grass stand suitable for light grazing within a shorter period.

Thus, this farmer's acreage has been reduced to 400 acres while he still has the labour and equipment to farm over three times this area and, conversely, the concentration of livestock per acre of farm has risen threefold while the potential food-producing land has been reduced by more than 70%.

This is just one example of numerous problems facing thousands of farmers along Britain's east coast and the coasts of Holland and Belgium. In Essex alone the loss of growing crops and other 'tenant right' considerations, apart from any expectation of profit, is stated to be well over £100,000. Loss of livelihood from the land, if computed in terms of £ s. d., would be colossal.

The Government has introduced a Coastal Flooding (Emergency Provisions) Bill which, at the time of writing, has had its second reading in the House of Commons. It is proposed to promote the rehabilitation of flooded agricultural land through schemes of acreage payments, ranging from £80 an acre for asparagus, bulbs and nursery stock to £4 an acre for permanent grass partly destroyed; payments will refer to crops which were in the ground on the 31st January.

The water hyacinth

EICHORNIA CRASSIPES, or the water hyacinth, is causing widespread damage in India and other parts of the Eastern tropics, particularly in its effects upon navigation on important rivers. It is indeed another case of an imported pest, for a Mr. Morgan, who once lived in Narayanganj, Dacca, is reported to have brought the water hyacinth to India from Brazil to improve the appearance of the grounds around his bungalow. Indeed, a popular name for this weed in the sub-continent is now 'Morgan's Vice'! It spreads alarmingly, for it multiplies both vegetatively and by seeding. Efforts have been made to utilise the water hyacinth. Its fibres have been investigated for paper-making and board-making. Its ashes have been tried as a low-grade potassic fertiliser. But the most hopeful development seems to be its use as a compost material; large-scale tests in this direction are said to have been completely successful. A fourth possibility that has been suggested is the use of the weed as pig fodder—in China and Hong Kong the water hyacinth is not regarded as a pest owing to its value for pigs.

However, eradication may be the eventual solution. Recent tests in Bengal and the Sudan have shown that the weed is susceptible to 2, 4-D, and that little harm is done to other flora and fauna in *stagnant* water when this substance is applied by spraying. The query still outstanding is the effect upon water that may later be used for drinking.

Agricultural progress in Malaya

THE Report of the Director of the Department of Agriculture for the Federation of Malaya for the years 1950-51, which has recently appeared, is an appropriate subject for comment in an issue which is particularly concerned with the Rubber Industry, since in the minds of the majority of people agriculture in Malaya is to a large extent coincidental with rubber growing. A perusal of the Report, however, serves to indicate how far from the truth such a conclusion is. Actually, the work of the Department of Agriculture is now only connected with the rubber industry in a relatively minor degree. Initially, when the Department of Agriculture was first organised in 1904, its principal preoccupation was with the problems of the rubber industry and in solving many of them it rendered yeoman service to the pioneer producers of rubber in those earlier days. In the 1920s, however, it was decided that the need for research in the rubber industry was so pressing that the organisation of a separate and independent Rubber Research Institute was necessary and that henceforth the work of the Agricultural Department should be mainly concerned with fostering and encouraging other agricultural industries, particularly in view of the dangers that were apprehended by many people from undue dependence on what was regarded as a single crop economy.

Actually this view must be to an extent regarded as somewhat exaggerated inasmuch as even at that time there existed some 16 different crops other than rubber which were cultivated on some scale, while at least two and possibly three would in most countries be counted as considerable industries with cultivated areas running into

several hundreds of thousands of acres, namely, coconuts and rice, the third crop being pineapples.

The Rubber Research Institute was actually founded in 1926 and since then the work of the Department of Agriculture has continued along the lines suggested, with not inconsiderable success. Despite the tragic interruption of its work by five years of Japanese occupation, considerable progress has been made in developing crops other than rubber in the peninsula, while the Department, despite the disintegration it suffered during the invasion and a chronic shortage of essential trained staff, has accomplished a large amount of useful work. In 1951 the area under rice totalled 875,000 acres, the highest ever recorded; coconuts occupied 500,000 acres which is considerably less than pre-war, the Japanese having destroyed something like 100,000 acres; on the other hand, oil palms had increased the area planted to 98,000 acres; there were 8,500 acres under tea and among new crops cocoa was giving promising indications, while jute and Manila hemp were among the many crops under trial. Bearing in mind the difficulties and dangers under which the work was done on account of the constant threat of banditry and the persistent staff shortages, one can only agree with the Director that the keenness and steadfastness of the staff is a matter for legitimate pride.

Rubber without trees

WE recently commented upon the plans for synthetic rubber production in Brazil (WORLD CROPS, 1953, 5, 1, 1). Since those words were written, news has been published about discussions on synthetic rubber production in Britain. These would seem to have been very exploratory for they involved only one Government department, a regional development board, a rubber manufacturing company, and an oil industry association. It was decided with full agreement that synthetic rubber production in Britain is desirable, but that at present there are too many technical obstacles to attempt a start. Malayan producers have been granted no more than a reprieve from anxiety, but it may prove quite a lengthy reprieve. Some of the essential raw materials for rubber synthesis are those today known as 'petro-chemicals,' by-products of modern oil refining or products of oil processing. Although Britain's output of chemicals from oil is expanding promisingly, no single refinery could at present produce enough of the raw materials needed by the smallest-sized synthetic rubber plant that is economic to run. It would seem to be a hard fact about factory-made rubber that only a very large plant can possibly pay; so Britain cannot compromise in any synthetic rubber decision by 'dabbling' with a small plant. It might also be remembered that the huge synthetic rubber developments in America have been state-financed and state-run and with some justice natural rubber interests have constantly claimed that they have faced unfair and subsidised competition. These plants are due to be handed over to private enterprise in 1953, and if the take-over prices are realistic and not under-valued by writing-off it is expected that the price of synthetic rubber will rise by 10% to 30%.

Britain's position with regard to synthetic rubber will always be difficult. Malayan rubber is Commonwealth rubber and Malaya's prosperity is vital. On the other hand, rubber is an indispensable industrial and military commodity, and Britain's dependence upon distant natural sources is strategically dangerous. War that might again cut Malaya off, or increased unrest in Malaya, are factors that cannot be ignored. One large synthetic plant would be at least a partial insurance against these risks. But if ever a synthetic plant is built, it will involve huge capital outlay and it can hardly remain a frozen asset; it would have to work and produce whether or not the supply of rubber from Malaya was abundant.

TCA

TCA, or trichloracetic acid, has of late years been meeting with increasing acceptance, particularly in the U.S.A., where it was first introduced in 1949, for the control of grasses which are, of course, not susceptible to control by the hormone weedkillers such as 2, 4-D or MCPA. Actually it is reported that in the U.S.A. some 12,000,000 lb. of the sodium salt were produced and consumed in 1951. In the U.S.A. it is stated to be of particular value for the control of Bermuda grass (*Cynodon dactylon*), Johnson grass (*Sorghum halipense*) and Quack grass (*Agropyron repens*). It is used as a water spray solution at the rate of 40 to 50 lb. per acre.

Outside the United States testimony to its effectiveness as a herbicide comes from Puerto Rico, where recently T. K. Muzik and H. J. Crusado have reported it to be particularly effective against Bermuda grass and Para grass (*Panicum purpurescens*). The same authors report that when to TCA is added various other substances, *e.g.* pentachlorophenol, dinitro-sec-butyl-phenol and various aromatic oils, the rapidity of action of TCA is greatly enhanced and the thoroughness of its kill increased. It is suggested that the addition of a contact herbicide may make tops of plants more permeable to TCA or may prevent absorption by the leaves, thereby permitting more TCA to reach the roots of the plants, since it is to be borne in mind that TCA acts primarily on the roots.

It seems not unreasonable to expect that under tropical conditions the use of TCA is likely to extend rapidly if the results recorded in Puerto Rico are confirmed elsewhere.

Various grasses are troublesome weeds in cultivation in the tropics and often the control of the spring of grasses in cultivated fields at the onset of the rains presents an almost insoluble problem. If TCA provides the solution it would be a great step forward. The main question is whether it can be put on the market in tropical countries at prices which would make its regular employment an economic proposition.

U.K. farm economics

LAST year the annual review of the economic conditions and prospects of the agricultural industry in the United Kingdom resulted in a system of price fixing and production awards calculated to stimulate home food production, particularly livestock products, and restore the tillage acreage which had declined since the end of the war. This was the start of a long-term policy outlined by the present Conservative Government with the ultimate aim of raising net output to at least 60% above the pre-war level by 1956.

At this year's price review the Government have indicated satisfaction with results achieved so far. They state that production and use of grass have improved, there has been an increase in the tillage area, also increases in livestock numbers and output of livestock products.

The policy of aiming for the 60% increase within the next three years still stands. The general policy of the Government to check rising costs has evidently had some considerable success in the agricultural industry for, they state, the extra replacement costs which farmers have had to bear during the past 12 months are estimated at £17 million, compared with £40 million in 1951-52.

Estimated increases in costs are nearly £26½ million; this figure includes the effect of the ending of the subsidy on feeding stuffs, announced in early March. Of this amount, £22 million refers to commodities which come within the scope of the price review under the Agriculture Act of 1947. This may be further subdivided into £17 million and £5 million, which are the shares of the cost increases for fixed-price commodities and decontrolled commodities (cereals and eggs) respectively.

The total *awards* on fixed price commodities total £15½ million, £1½ million short of the estimated increases in costs. This, the Ministry hopes, will be made up by greater efficiency from the farmers themselves.

The individual price awards—and they can hardly be expected to please all sections of primary producers to the same degree—slightly favour the livestock producers and will be a little disappointing to milk producers; grain producers will remain at about the same level. On the whole, farmers will be reasonably satisfied with the outcome and the Government's long-term policy will be allowed to continue towards its goal for 1956.

Trace elements and time

MUCH more research has been devoted to the amount of trace elements needed by plants than to the times or stages of growth when supplies are required. A recent letter in *Nature* (1953, **171**, 438-9) reports an exceedingly interesting experiment on the time-table of manganese requirements for tomato plants. Complete control over nutrient supply was obtained by using the so-called ' water-culture ' method of investigation. In the first experiment plants were grown so that manganese could be supplied or withheld in four consecutive two-week periods during growth; in total eight different patterns of manganese supply were compared. It was found that an absence of manganese in the first two-week period did not adversely affect growth. Broadly, normal development from germination to early fruit formation was obtained provided that manganese was available during the middle periods; that is, in the third to sixth weeks during the total period of eight weeks.

In the second experiment narrower time control was set, and it was then found that no adverse effects upon development occurred if manganese was available for just one week in the third fortnight after sowing. 'The manganese absorbed during this period was sufficient for normal growth for a further four weeks.'

These results would seem far from academic. We do not mean that growers need develop a calendar complex towards trace elements. Broadly speaking, it does not much matter when manganese is present so long as it is there at a reasonably early stage. But in other manganese research it has often been found that foliage spraying was far more effective in correcting manganese deficiencies than soil applications, and the common belief has been that the soil-applied manganese became ' locked up ' by the same soil factors that had ' locked up ' the natural supply of manganese. Another interpretation can now be put forward. Foliar spraying may have been more effective because it took place at or near the critical *time* of need, whereas soil applications failed to reach the plant until after that critical phase of development. In this whole question of method of application of trace elements there have been plenty of anomalous results. This time factor may be the missing factor. *When* seems as influential a condition as *how* or *how much*.

The Colston symposium

AMONG universities Bristol is, so far as we know, unique in that there exists in the city a society, the membership of which is composed of leading local residents, named the Colston Research Society, the object of which is to aid and encourage the development of research in the university itself. In view of the many sources of revenue available for the prosecution of research projects, the Society has devoted its energies of late years to the organisation of annual conferences or, as they have been termed, symposia dealing with some particular aspect of research. So far five such conferences have been held, the subjects of which have ranged over an exceptionally wide field, including such diverse topics as British Colonial Administration, the Drama in Britain and the Suprarenal Cortex. This year the topic chosen was the Influence of Insecticides on Colonial Development, a subject which must be regarded as particularly appropriate having regard to the traditional close connection of the City and University of Bristol with colonial development and enterprise and also the ever-growing importance of insecticides as tools for increasing agricultural production.

The symposium, which was organised under the direction of Professor T. Wallace, Director of Long Ashton Experiment Station, with Dr. J. T. Martin of the same institution as Secretary, took place between March 23 and March 27.

Among other topics discussions dealt with means of making modern insecticides available to indigenous cultivators on smallholdings in the colonies, and on devising inexpensive and effective methods of applying them under these conditions. The attendance included a number of leading authorities on the subject, both in Great Britain and the Colonies, and when the proceedings are published they will certainly be found to contain papers and discussions of high value and interest.

The annual dinner of the Colston Society, held on March 25, was noteworthy for the admirably phrased and closely reasoned address delivered by Sir Edward Salisbury, Director of the Royal Gardens, Kew, and Vice-President of the Royal Society. We hope to publish a brief report of the symposium in the next issue of WORLD CROPS.

The Plantation Rubber Industry

D. H. GRIST, Dip. Ag. (Cantab.)
Late Agricultural Economist, Malaya

In this article the author reviews the salient points in regard to the production of rubber, and shows how the position of natural rubber has been challenged, especially since the last war by competition from reclaimed rubber and more particularly by synthetic rubber substitutes.

RUBBER is obtained commercially from a number of plants. *Caucho* rubber is extracted from a tree, *Castilloa elastica*, found in Central America and parts of Brazil, and *Ceara* rubber from *Manihot glaziovii;* both these rubbers are of fairly good quality. There are some 37,000 acres of *Ceara* rubber plantations in Tanganyika, Uganda and Kenya and about 300 acres of *Caucho* in Trinidad and Tobago. *Ficus elastica*, indigenous in Assam and Burma, has been developed on plantation lines in Indonesia and New Guinea, there being nearly 7,000 acres in Indonesia and 2,000 acres in New Guinea. Guayule (*Parthenium argentatum* Gray) is a shrub, native of the desert areas of Mexico and Texas, which has been cultivated in Arizona and California as a commercial source of rubber.

Hevea brasiliensis

The most important source of rubber, however, is the tree *Hevea brasiliensis*, from which *Para* rubber is obtained. It is indigenous to Brazil, from which country up to the end of the last century the world supply of natural rubber was obtained from trees growing wild in the Amazon Valley, supplemented by rubber obtained from other species of wild trees and shrubs in America, Africa and Asia. The amount of rubber so obtained was usually around 40,000 tons annually.

As early as 1834 Thomas Hancock, an English rubber manufacturer and the inventor of rubber vulcanisation, suggested the possibility of growing rubber in the East owing to the high cost of the Brazilian product. It was not until 1873, on the instigation of Sir Joseph Hooker, Director of Kew Gardens, London, that a Mr. Farris collected in Brazil and sent to Kew about 2,000 seeds. Only 12 germinated and these failed to develop. Three years later Mr. H. A. Wickham (later Sir Henry), a traveller and planter in Central America, succeeded by great resourcefulness in delivering to Kew, in good condition, about 7,000 seeds which he had procured from the forests in the highlands between the Tapajoo and Madeira Rivers in Brazil.

Only about 2,800 plants were obtained from these seeds at Kew. Of these, 1,919 were sent to Ceylon and arrived in excellent condition. Fifty of these were despatched to Singapore, but all perished on the voyage. In the following year, however, two more cases of plants reached Singapore in good condition and were established at Singapore and at Kuala Kangsar in Perak. By 1882 seeds from the Kuala Kangsar plants had been distributed to Java, Ceylon and India. These trees, together with trees subsequently grown successfully in Singapore, became the nucleus of the plantation rubber industry in Asia, but it was not until 1895 that the rubber planting industry expanded on a commercial scale. Today over 90% of the world production of natural rubber is produced on the plantations and smallholdings in South-East Asia.

In 1905 the rubber plantations of Malaya yielded less than 200 tons, the jungle product of South America still monopolising the market with about 35,000 tons and the rest of the world with 27,000 tons derived from various indigenous rubber-yielding plants. It was not until about 1910 that a real shortage of raw rubber began to be felt, due to the phenomenal development of the motor vehicle industry brought about by the rapid development of the internal combustion engine and the consequent demand for rubber tyres and tubes. In 1913 rubber plantations in the East—chiefly in Malaya, Ceylon and the Netherlands Indies—produced more rubber than was obtained from South America and in the following year this output exceeded the production of wild rubber from all sources.

Fairly young rubber trees on an estate in Java

Areas under plantation rubber

Hevea brasiliensis will thrive over a wide range of soils, but it is particularly susceptible to temperature and rainfall conditions. It requires an equable tropical temperature ranging between 70° and 90°F. and a well distributed and high rainfall of 80 to 100 in. a year. These conditions are met with in Malaya and Indonesia and rather less ideally in some other Asiatic countries of production. Somewhat similar conditions obtain in the West African countries of production. The pre-eminence of Malaya and Indonesia, however, is not due alone to suitability of climate, but to the abundance of labour available to develop the plantations.

The present world area under plantation rubber is stated in Table 1.

Yields of rubber

Hevea brasiliensis comes into production about six years from planting; it is in full production from about the fourteenth year and may have an economic life of 30 years or more, depending largely on soil conditions, cultivation and the treatment it receives. The yield per acre varies greatly between territories, the highest yields being

obtained in Malaya, Indonesia and adjacent countries, with a definite diminution of yield in India, Ceylon and Burma and some of the African territories. The average yield of good estate mature trees obtained from ordinary seedlings is about 500 lb. per acre per annum in Malaya and Indonesia; on poor soils the yield may be only 200 lb., while on exceptionally good soils it may be 700 lb. annually. In these territories yields on smallholdings tend to be greater than on the large estates, due in part to closer planting and better soil conservation.

Yields of rubber vary seasonally. There is a marked decline in yield during the six weeks or so when the trees shed their foliage, a phenomenon largely governed by rainfall variation. As will be seen on the graph, this period of 'wintering' varies for different territories: in Malaya it takes place about February; in Java about July.

The present system of bud grafting and the planting of improved clonal seed as a means of increasing yields has already had spectacular results and is destined to affect materially the economics of rubber production.

Improved planting material

Observations on the yields of trees grown from seed showed that 30% of the trees on a given area yielded about 70% of the crop of rubber. This great variation in yield of individual trees led to the propagation of trees from buds obtained from parent trees of proved high yield. Early work on bud grafting was carried out in the Netherlands Indies, the first results being published about 1918. The system has now largely superseded the planting of seed from a mixed population of trees. Yields of bud-grafted rubber before the war were at least twice those from trees grown from mixed seed, yields since the war have been greater, and even higher yields are anticipated as a result of further investigations in bud grafting.

High yields are also obtainable by planting specially selected seed known as clonal seed. There are over 116,000 acres in Malaya planted with high-yielding clonal seed. The total area of rubber planted with high-yielding rubber (bud-grafted and clonal) now exceeds 1,500,000 acres, of which 618,000 acres are in Malaya, 559,000 acres in Indonesia, 110,000 acres in Ceylon, 146,000 acres in Indo-China and 61,000 acres in Liberia.

Rubber production

The annual production of natural rubber has increased from 45,000 tons in 1900 to 1,875,000 tons in 1951 (see graph). Of the present world production, 86.6% is grown in four Asian countries, *viz.* Indonesia 42.9%, Malaya 32.5%, Thailand 5.8%, Ceylon 5.6%. Details of production in these four countries during the past four years is shown in Table 2.

The production of rubber in the rest of the world is shown in Table 3.

The above figures not only show the importance of certain countries as producers of rubber, but also the very great share of this production by smallholders (owners of less than 100 acres), all of whom are Asiatics. In the four countries shown in Table 2 Asiatic smallholders produced 61% of the 1951 production of rubber. Production of rubber on Asiatic-owned properties, however, was substantially greater than this, for of the 1,975,000 acres of estates of 100 acres and over in Malaya over 523,000 acres are Asiatic owned, of which 107,000 acres are planted with bud grafts or approved clonal seedlings. In Malaya approved budded material and clonal seedlings are readily available for smallholders. Of the total planted area under rubber in Malaya, 59% is Asiatic owned.

Latex from the rubber tree is converted into rubber by the addition of a coagulant. The coagulum is processed and is usually

TABLE 1
AREA UNDER PLANTATION RUBBER
('000 acres)

Territory	*Estates*	*Smallholdings*	*Unspecified*	*Total*
Indonesia	1,567	3,179	—	4,746
Malaya	1,975	1,580	—	3,555
Thailand	—	700	—	700
Ceylon	343	312	—	655
Viet-Nam and Cambodia	311	20	2	333
Sarawak	18	222	—	240
India	103	67	—	170
North Borneo and Brunei	86	69	—	155
Burma	68	42	—	110
Philippines	8	—	—	8
Portuguese Timor	1	—	—	1
Total Asia	4,480	6,191	2	10,673
Belgian Congo	145	47	—	192
Liberia	77	18	—	95
Tanganyika	30	—	—	30
Nigeria	19	101	—	120
Uganda	10	—	—	10
Kenya	3	—	—	3
Nyasaland	1	—	—	1
French Cameroons	21	—	—	21
Gold Coast	5	—	—	5
Total Africa	311	166	—	477
Total America	—	—	30	30
Total Oceania	25	—	—	25
TOTAL WORLD	4,816	6,357	32	11,205

The American figures include 17,250 acres in Brazil, and the Oceania total includes 20,800 acres in Papua.

TABLE 2
PRODUCTION OF RUBBER IN FOUR PRINCIPAL COUNTRIES
('000 tons)

Year	*Indonesia*			*Malaya*			*Ceylon*			*Thailand*	*Total*		
	Estates	*Smallholdings*	*Total*	*Estates*	*Smallholdings*	*Total*	*Estates*	*Smallholdings*	*Total*	*Smallholdings*	*Estates*	*Smallholdings*	*Total*
1949	168.0	263.8	431.8	400.8	270.7	671.5	69.5	20.0	89.5	94.2	638.3	648.7	1287.0
1950	175.2	521.3	696.5	376.7	317.4	694.1	85.5	28.0	113.5	112.2	637.4	878.9	1516.3
1951	213.3	591.9	805.2	328.8	276.6	605.4	83.5	21.5	105.0	108.8	625.6	995.0	1620.6
1952	—	—	738.0	—	—	584.2	—	—	96.5	97.9	—	—	1516.6

TABLE 3
PRODUCTION OF RUBBER IN THE REST OF THE WORLD
('000 tons)

Year	*Vietnam and Cambodia*	*India*	*Sarawak*	*Other Asian*	*Africa*	*Brazil*	*Other Latin American Countries*	*Oceania*	*Total*
1949	43.0	15.6	39.5	30.8	45.0	21.3	6.0	0.9	202.1
1950	48.5	15.6	55.6	39.3	54.5	19.4	7.5	2.3	242.7
1951	52.1	17.1	42.4	34.7	72.0	20.8	9.0	2.7	250.8
1952	—	19.9	31.5	—	—	—	—	—	—

Young rubber plants on a Sumatra estate

TABLE 4

NATURAL RUBBER LATEX EXPORTS FROM PRINCIPAL TERRITORIES
(Long tons of dry rubber content)

Year	Malaya	Indonesia	Ceylon	Indo-China	North Borneo	Liberia	Others	Total
1927 ..	2,634	83	—	—	—	—	—	2,717
1932 ..	5,193	3,488	2	—	—	—	—	8,683
1937 ..	19,408	13,651	4	7	307	1,139	—	34,516
1940 ..	22,269	17,559	10	7	644	4,259	—	44,748
1947 ..	26,595	53	446	170	—	9,168	96	36,528
1948 ..	39,956	18	625	241	—	6,006	224	47,070
1949 ..	45,731	1,397	879	293	—	7,720	163	56,183
1950 ..	73,219	7,607	1,272	634	—	16,286	—	99,018
1951 ..	60,386	9,750	1,426	856	—	13,505	—	85,923
1952 ..	48,198	n.a.	1,533	747	—	11,168	—	n.a.

n.a.—figures not yet available

TABLE 5

PRODUCTION OF RECLAIMED RUBBER

Year	U.S.A.	U.K.	France	Germany	Australia	Canada	Other Countries	Total
1941 ..	274,202	—	9,987	—	—	—	—	284,189
1942 ..	285,114	18,275	6,625	—	—	—	—	310,014
1943 ..	303,991	36,587	7,889	—	6,771	4,708	2,892	362,838
1944 ..	260,607	28,690	7,194	—	7,206	3,153	4,424	311,274
1945 ..	243,309	22,317	9,210	—	5,819	3,307	5,953	289,915
1946 ..	295,612	27,798	15,360	—	6,410	3,967	1,645	350,692
1947 ..	291,395	22,431	—	—	5,973	4,125	2,134	326,058
1948 ..	266,861	24,614	—	—	5,305	4,323	2,297	303,400
1949 ..	224,029	20,946	—	24,147	5,899	3,475	2,312	280,808
1950 ..	313,006	30,083	—	24,500	8,248	4,456	3,023	383,316
1951 ..	365,933	36,729	—	27,355	8,608	5,077	3,862	447,564

TABLE 6

PRODUCTION OF SYNTHETIC RUBBERS
(tons)

Year	Canada	Germany	U.S.A.	U.S.S.R.	Total
1933	—	—	—	2,000	—
1936	—	—	—	44,000	—
1938	—	5,000	1,000	64,000	70,000
1941	—	69,361	8,114	120,000	200,000
1946	50,981	15,557*	740,026	—	806,564
1947	42,393	8,229*	508,702	—	559,324
1948	40,455	3,388*	488,343	—	532,186
1949	46,642	—	393,689	—	440,331
1950	58,440	—	476,184	—	534,624
1951	62,293	—	845,159	—	908,381
1952	74,272	—	798,566	—	872,838

* British Zone only since 1945. Production was suspended in July, 1948.

exported in the form of either sheet or crepe rubber. During recent years an increasing amount of rubber has been marketed in the form of concentrated latex. Table 4 shows the growth of the output of rubber in this form.

Restriction of production

Owing to a general trade depression in 1921, the rubber-producing industry was threatened with ruin. With the object of narrowing the difference between production and consumption, thereby absorbing the excessive stocks of rubber on the market and stabilising the price of rubber, the British Government put into force a scheme for restricting exports. Unfortunately, the application of this unilateral scheme, by enhancing the price of raw rubber, encouraged the rubber-reclaiming industry in the U.S.A., and also led to increased planting of rubber in the Netherlands Indies, which was outside the scheme. This scheme of restriction was abandoned in November 1928. The world market was again flooded with rubber and the effect was greatly enhanced by the fall in consumption during the world economic crisis of 1930 to 1933. The plight of the rubber producers by the end of 1933 was infinitely worse than it had been in 1921.

An international scheme of regulation of exports of rubber, in which all major producing countries participated, was brought into operation in June 1934. Under the regulations no new planting was permitted from June 1934 to the end of 1948, with the exception of experimental planting on new land up to $\frac{1}{4}\%$ of the total planted area. The percentage release of the basic quota during rubber regulation varied from 55 to 87 until 1941, when from January to September the release was 100%, with the proviso that this could be exceeded if found possible. The scheme came to an end with the occupation of Malaya and Indonesia by the Japanese.

Reclaimed rubber

Reclaimed rubber is not primarily a substitute for raw rubber, except when prices of raw rubber are excessively high or supplies scarce, as during the second world war. Most countries with a rubber manufacturing industry have also a rubber reclaiming industry. Reclaimed rubber is in demand for certain types of goods, and for this reason its market is assured even when the price of the raw natural product is low. Table 5 shows the growth of the reclaiming industry, the figures including both natural and synthetic reclaimed rubbers.

Russian reclaimed rubber before the war was about 25,000 tons annually; present production is not published.

Synthetic rubber

The first synthetic rubber was made by the Germans during the 1914-18 war. More recently several synthetics have been made in Germany, known as Buna, which are stated to be very satisfactory, especially when blended with natural rubber. During 1942-44 German production exceeded 100,000 tons annually. Russian production before the war was also considerable; though many of the Russian plants were destroyed during the war, it is certain that the industry has been re-established in that country, probably with the aid of plant removed from Germany. Several synthetics have been developed in the U.S.A. and during the second world war synthetic rubber production capacity was increased in that country to 1,000,000 tons annually to replace the loss of the Asian rubber areas. The U.S.A. Government owned synthetic plants at the beginning of 1949 having a capacity of 1,000,000 tons, in addition to which there are a number of privately owned plants.

While most synthetic rubber is produced in solid form, a number of synthetic latices are also manufactured in the United States and Canada.

Rubber consumption

Natural rubber is used in manufacture in its solid form or as a latex. Similarly, synthetic rubbers are made as solids or as latices. Reclaimed rubber is made from old rubber goods, such as tyres and tubes, both natural rubber and synthetics, or from a mixture of both types.

The type of rubber used in manufacture depends on the comparative prices of the three types and on the nature of the manufactured article.

The most important use of rubber is in the manufacture of tyres and inner tubes. It is probable that about 65% of the total rubber consumed is used in transportation.

Many of the rubber-like materials used as substitutes for rubber are, strictly speaking, 'plastics' rather than synthetic rubbers. The most important synthetic rubbers are butadiene - styrene copolymers, *i.e.* GR-S, largely used in tyre manufacture; butyl rubber, used for inner tubes; neoprene, used for practically all purposes for which natural rubber is employed; and butadiene-acrylonitrile, or N-type rubbers, mainly used where oil resistance is of importance.

The extent to which reclaimed rubber can be used is limited; in excess it has an adverse effect on durability of the finished article.

Figures for the production of natural rubber latex are given in Table 4. In addition, during the past seven years synthetic latex has been increasingly produced and used. Production of natural and synthetic latices since the war is given in Table 7. Latex is largely used for the manufacture of 'foam rubber' in upholstery, mattresses, and the like. It is thought that a large potential market exists for articles made from rubber in its liquid state.

Interior of a rubber-drying shed in Eastern Sumatra

TABLE 7

PRODUCTION OF NATURAL AND SYNTHETIC LATICES

(Tons of dry rubber content)

Year	*Natural Latex*	*Synthetic Latex*	*Total Latex*
1945 ..	5,216	20,250	25,466
1946 ..	12,341	38,413	50,754
1947 ..	36,528	28,563	65,091
1948 ..	47,070	26,040	73,110
1949 ..	56,183	19,761	75,944
1950 ..	100,000	28,525	128,525
1951 ..	87,500	31,099	118,599

Since the last war consumption of rubber of all kinds, natural, synthetic and reclaimed, has considerably expanded. Table 8 illustrates the position in this regard.

The above figures show the very great and increasing importance of synthetic rubbers. In this connection Kellett[1] has observed: 'In so far as the relative consumption of natural and synthetic rubber is concerned, it is regretted that in regard to the largest consuming country it is impossible to draw any conclusions as to the demand for either kind. This is partly due to the fact that under present U.S. legislation there is a minimum mandatory usage of synthetic rubber laid down by Government. On the other hand, it is impossible to draw any firm conclusions from countries outside the U.S.A., with the possible exception of Canada, because (*a*) synthetic rubber can only be obtained from dollar countries, and (*b*) very few countries have sufficient long experience of using synthetic.

'So far as the U.S.A. is concerned, the present mandatory use is confined to transportation equipment, while the non-transportation field, where in many cases synthetic would be preferred on its merits, is completely free.'

Despite the limitations on its value set out in the two previous paragraphs, Table 9 indicates the relative use of natural and synthetic rubber during the last few years. In every case the consumption of Russian synthetic rubber has been excluded.

TABLE 8

CONSUMPTION OF NATURAL, SYNTHETIC AND RECLAIMED RUBBER

(tons)

Year	*Natural Rubber*	*Synthetic Rubber*	*Reclaimed Rubber*	*Total*
1946	555,000	912,500	323,877	1,791,277
1947	1,110,000	625,000	334,960	2,069,960
1948	1,422,500	480,000	306,394	2,206,894
1949	1,437,500	450,000	285,308	2,172,808
1950	1,705,000	580,000	374,995	2,659,995
1951	1,500,000	812,500	425,623	2,738,123
1952	1,447,500	885,000	—	—

Rolling crepe rubber in a factory in Eastern Sumatra

Stocks of rubber

Stocks of natural rubber in consuming countries include those held by Government for purposes of national security and those held by dealers and manufacturers. Before the war London was the most important rubber market in the world; today most countries import direct from producing territories. Warehouse stocks in London are, therefore, usually only around two months' consumption. In America a stock equivalent to five months' consumption is now considered normal, whilst in most other consuming countries manufacturers' stocks are usually maintained at about two to three months' consumption.

The London average price of rubber since 1900 is shown in the graph, also the world position of natural rubber during this period. The natural, synthetic and reclaimed rubber prices for the past 10 years are stated in Table 11.

The figures stated in the above tables show that both in 1951 and 1952 production of natural rubber exceeded consumption by over 300,000 tons. Practically the whole of this surplus went into the United States' stockpile, but as stockpiling has now ceased it would appear that prices of future production will drop. Though consumption outside the U.S.A. is steadily increasing, production is unlikely to increase at the

A mature seedling tree tapped on the full circumference system. Tapping is carried out every fourth day

TABLE 9
SYNTHETIC RUBBER CONSUMPTION AS A PERCENTAGE OF TOTAL RUBBER CONSUMPTION

Twelve Months Ending	*United States*			*Canada*			*Rest of World*	*Total World*
	Transport	*Non-transport*	*Total*	*Transport*	*Non-transport*	*Total*		
December 1946 ..	71.1	79.1	73.2	76.6	73.2	75.7	31.2	62.2
December 1947 ..	46.7	58.8	49.8	47.2	48.2	47.5	6.6	36.0
March 1948	43.5	52.2	45.9	42.0	41.2	41.8	4.6	31.7
June 1948	40.9	47.4	42.7	36.9	36.5	36.8	3.8	28.6
September 1948 ..	40.4	44.8	41.7	34.3	35.3	34.6	3.0	27.0
December 1948 ..	40.5	43.3	41.3	32.6	34.4	33.1	2.2	25.3
March 1949	41.2	42.8	41.7	31.9	34.1	32.5	2.1	24.7
December 1950 ..	41.6	44.8	42.8	—	—	—	—	25.4
December 1951 ..	61.9	63.6	62.5	33.4	45.6	37.3	4.5	30.3

TABLE 10
STOCKS OF RUBBER
('000 long tons)

Year	*Natural Rubber*				*Synthetic*	*Reclaimed*	*Total*
	In Producing Territories	*In Consuming Countries*	*Afloat*	*Total*			
1946 ..	237.5	492.5	210	940	140	43.2	1,123.2
1947 ..	230	375	240	845	77.5	43.9	966.4
1948 ..	235	300	235	770	125	40	935
1949 ..	237.5	255	227.5	720	110	36.7	866.7
1950 ..	245	247.5	275	767.5	60	43	870.5
1951 ..	242.5	315	255	812.5	142.5	57	1,012

TABLE 11
NATURAL, SYNTHETIC AND RECLAIMED RUBBER PRICES
(per lb.)

Year	*Natural Rubber*		*Synthetic Rubber*			*Reclaimed Rubber*	
	London	*New York*	*GR-S*	*Neoprene*	*Butyl*	*U.K.*	*U.S.A.*
	s. d.	*U.S. cents*	*U.S. cents*	*U.S. cents*	*U.S. cents*	*d.*	*U.S. cents*
1941 ..	1 $1\frac{19}{32}$	22.10	—	65	—	$5\frac{13}{32}$	$6\frac{1}{4}$
1942 ..	1 $1\frac{3}{4}$	22.50	50	65	33	$5\frac{1}{2}$	$6\frac{1}{2}$
1943 ..	1 6	22.50	$26\frac{3}{8}$	$41\frac{1}{4}$	$19\frac{7}{8}$	$5\frac{1}{2}$	$6\frac{1}{2}$
1944 ..	1 6	22.50	$18\frac{1}{2}$	$27\frac{1}{2}$	$15\frac{1}{2}$	$5\frac{1}{2}$	$6\frac{3}{4}$
1945 ..	1 6	22.50	$18\frac{1}{2}$	$27\frac{1}{2}$	$15\frac{1}{2}$	$5\frac{1}{2}$	7
1946 ..	1 $4\frac{7}{8}$	22.50	$18\frac{1}{2}$	$27\frac{1}{2}$	18	$5\frac{1}{2}$	$7\frac{1}{4}$
1947 ..	1 $0\frac{11}{32}$	20.97	$18\frac{1}{2}$	$29\frac{3}{8}$	$18\frac{1}{2}$	$5\frac{1}{2}$	8
1948 ..	1 $0\frac{29}{32}$	22.01	$18\frac{1}{2}$	32	$18\frac{1}{2}$	$5\frac{23}{32}$	$8\frac{1}{2}$
1949 ..	0 $11\frac{25}{32}$	17.56	$18\frac{1}{2}$	32	$18\frac{1}{2}$	$5\frac{1}{2}$	$8\frac{3}{8}$
1950 ..	2 $9\frac{9}{32}$	41.10	19	34	$18\frac{11}{16}$	$6\frac{1}{8}$	$9\frac{1}{16}$
1951 ..	4 $2\frac{27}{32}$	59.07	25	38	$20\frac{3}{4}$	$8\frac{7}{8}$	$10\frac{1}{2}$
1952 ..	2 $4\frac{11}{32}$	—	$23\frac{1}{2}$	38	$20\frac{3}{4}$	—	—

same rate, there must therefore be a burdensome surplus of rubber during the next few years, unless the U.S.A. increases the consumption of natural at the expense of synthetic rubber.

It is felt in the natural rubber industry that were the United States Government to abolish all mandatory use of synthetic and to sell their GR-S at a price which a manufacturer would have to charge if the industry were in private hands the plantation rubber industry would face the future with confidence.

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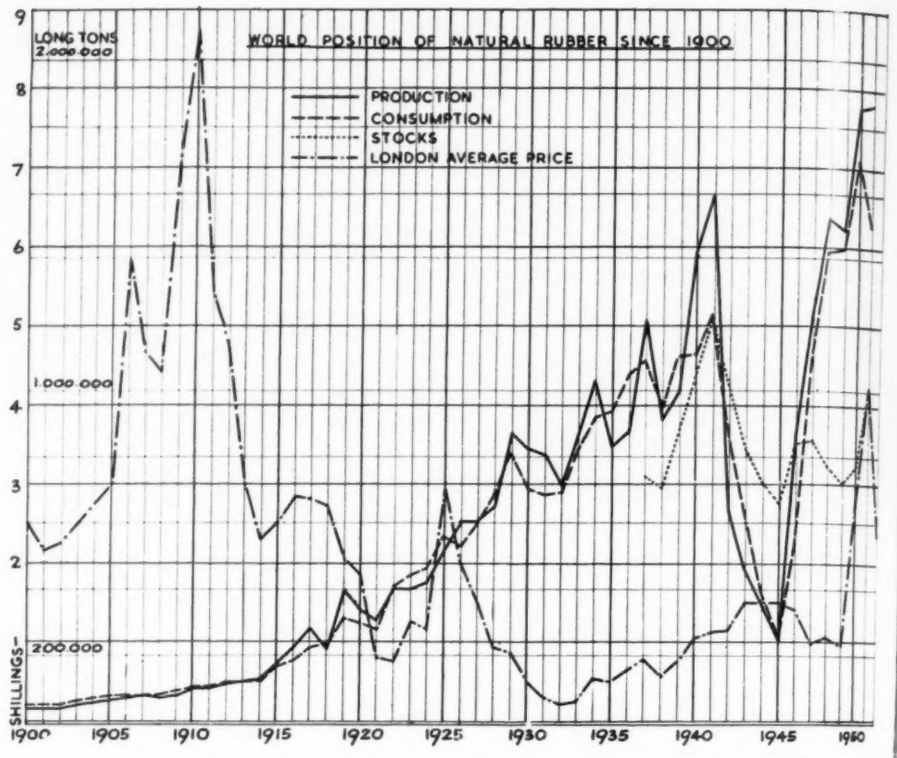
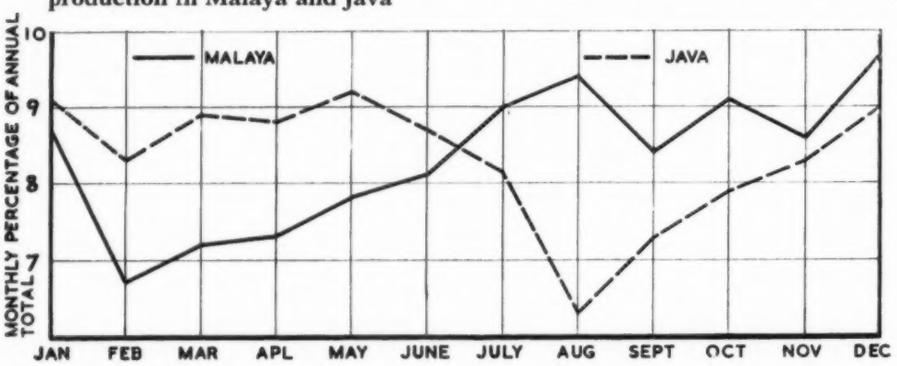
Photos: Pp. 175, 177, 178 and 179 (top), Indonesian Embassy, London; P. 179 (bottom), British Rubber Development Board.



The graph on the right shows the general world position of natural rubber since 1900; the graph below shows the seasonal variations in rubber production in Malaya and Java



Methoxone and Mergamma in the U.S.A. and Canada

Three and a half years ago Plant Protection Ltd. made an agreement with the Chipman Chemical Co. Inc., of New Jersey, whereby the latter made and marketed the British company's products in the U.S., when they appointed one of their staff, Mr. Leslie R. Reed, as an adviser to the Chipman Co. Recently Mr. Reed returned to this country and at a recent press conference discussed the progress made by two of Plant Protection's products in the U.S., namely, the selective weedkiller, Methoxone, and the seed dressing, Mergamma.

Although about 90% of the selective weedkiller sales in the U.S. at present consist of 2-4D, encouraging headway is being made with Methoxone. Mr. Reed commented on the fact that the rates of application of Methoxone in the U.S.A. were considerably lower than in the U.K.—$\frac{1}{8}$ lb./acre of active material compared with about 1 lb./acre in the U.K. This was because the American farmer was content to get weeds below crop level, whereas the British farmer demands 100% control.

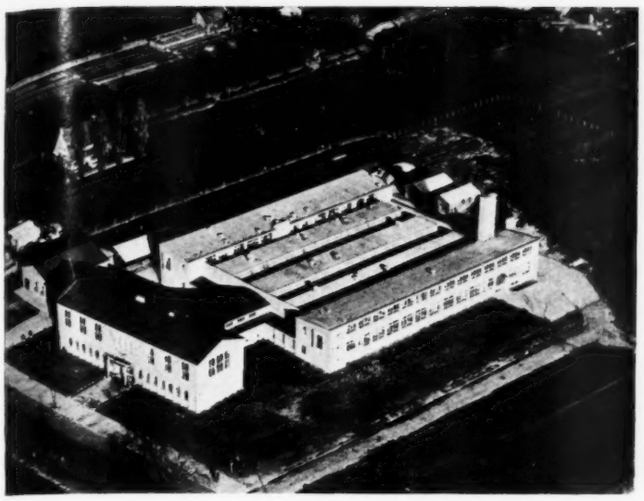
Mr. Reed later introduced Mr. A. D. St. Clair, head of the American section of the company's export department, who said that during the last two or three years sales of Mergamma in Canada have increased remarkably and he anticipated that in a year or two the company would be selling a million dollars' worth of this product in that country. High hopes were also entertained of Methoxone. At present these products were exported to Canada from the U.K. because there is no tariff problem in Canada to make necessary manufacturing arrangements as in the U.S. However, there is a possibility that the Canadian Industries Ltd. may later make these agricultural chemicals.

Fruit Futures in South Africa

'A new policy would be followed in the coming fruit export season by the South African Deciduous Fruit Board,' said the chairman at a fruit exporters' meeting in Paarl. He said fruit sent to Great Britain would still be on the time-and-variety basis, but all fruit sent to other markets would be pooled, and the losses and gains would be shared by the industry as a whole. The Deciduous Fruit Board was not a profit-making concern. Profits did not go to certain producers but back into the industry as a whole. He said the Government and the KWV were agreed that the Deciduous Fruit Board should keep its wineries, but the Wine Act had to be considered. Negotiations were going on for a compromise on control of the wineries.

Pineapples

Among the major fruits grown in the Union are pineapples, and the expected increase in future crops of pineapples is probably much greater than that of any other fruit. During the past four years or so the planting of pineapples in the coastal areas between Port Elizabeth and East London has been on a most extensive scale. The local consumption of pineapples in their fresh form, and even canned, is modest. At present there is a fairly steady volume of exports of fresh pineapples to Britain, but the preponderance of fruit that will come from the new plantings will go to processing factories.



(*Left*) **Aerial view of the Rubber-Stichting building, near Delft.** (*Right*) **Headquarters of the Institut Francais du Caoutchouc, in Paris**

The International Organisation of Research and Development in the Natural Rubber Industry

GEOFFREY GEE, Sc.D., F.R.S.

Director of Research, British Rubber Producers' Research Association

Of all tropical plantation industries rubber undoubtedly possesses the most elaborate and complete organisation for research. A particularly interesting point is that this form of organisation is on an international basis and not, as in the case of most other industries, strictly national. In this article, Dr. G. Gee, Director of the British Rubber Producers' Research Association, describes the position.

THE many different bodies interested in rubber research and development may be roughly classified into three groups:

(a) Organisations financed by the rubber-producing industries of a country or group of countries

The several national organisations of this type are for the most part co-ordinated under the International Rubber Research Board (I.R.R.B.) and International Rubber Development Committee (I.R.D.C.), as described below, and it is with them that this article will be mainly concerned.

(b) Organisations financed by individual producers or groups of producers

A few of the larger rubber estates or groups have their own research and development facilities. In addition, there exist co-operative groups which cannot be included in the above class of organisation, since their interests do not cover the rubber industry as a whole, but are sectional. One of the most important of these is AVROS (*Algemeine Vereniging van Rubberplanters ter Oostkust van Sumatra*), which caters for all the major crops of Sumatra, but is fundamentally concerned with natural rubber. Similarly, in Java there is the Centrale Proefstation Vereniging (CPV), whose activities are decentralised amongst separate experiment stations dealing with rubber, tea, quinine, etc. AVROS and CPV derive their finances on a basis of acreage under cultivation.

(c) Organisations financed by the manufacturing industry

All the large rubber manufacturing concerns have their own research and development departments. Since it is quite usual for approximately 2% of net sales to be devoted to this purpose, some of these departments, particularly in the U.S.A., are very large and have annual budgets which may exceed £1,000,000. Mention should also be made of the Research Association of British Rubber Manufacturers (R.A.B.R.M.), which is a co-operative research association, financed partly by voluntary contributions from the British rubber manufacturing industry and partly by a Government grant from the Department of Scientific and Industrial Research. The total expenditure of the R.A.B.R.M. in 1951 amounted to some £55,000. The research and development effort financed by rubber manufacturers is not devoted exclusively to natural rubber. In America, in particular, it would be truer to say that it is very largely geared to the synthetic rubber industry. This state of affairs is a natural consequence of the new developments in synthetic rubber production, which present the American manufacturers with a wide range of problems and opportunities concerned with the use of the stream of new synthetic materials. Since this article is concerned only with natural rubber research, no further reference will be made to the manufacturers' organisations.

British research and development organisations

(a) Rubber Research Institute of Ceylon

The first beginnings of a rubber research organisation in Ceylon date from 1909 and there has been a Research Institute in its present form since 1930. It is financed by a cess on all rubber exported from Ceylon and has always been concerned in the main with local problems arising from the cultivation and quality of the crop.

(b) Rubber Research Institute of Malaya

This organisation, which has been a member of the I.R.R.B. and I.R.D.C. since 1951, had its beginnings in 1925 and its constitution was revised to its present form in 1933. Its finance until 1948 was derived from a cess on rubber exported from Malaya. From 1948 onwards a slight modification has been in operation, which is described below in paragraph (d).

(c) London Advisory Committee for Rubber Research (Ceylon and Malaya)

In 1915 the need for co-operation between the Rubber Research Scheme of Ceylon (as it was then called) and rubber manufacturers in England and other consuming countries was recognised by the formation in London of the London Advisory Committee. Later a similar body was set up in London by the Rubber Research Institute of Malaya and in 1932 these two committees were fused to form the present London Advisory Committee for Rubber Research (Ceylon and Malaya). This committee obtains its funds from the research institutes of Ceylon and Malaya; in addition to its advisory function, it maintains a small scientific staff which undertakes experimental work.

(d) The British Rubber Producers' Research Association and the British Rubber Development Board

The Governments' signatory to the 1934 Rubber Regulation Agreement recognised the need for making additional funds available to finance research and development directed to discovering and extending industrial outlets for natural rubber. They agreed to collect a cess of 1d. per 100 lb. of rubber exported from British, Netherlands and French territories and to use the funds thus created to establish research and publicity organisations. The funds were not pooled; those deriving from British Commonwealth sources were applied to the establishment of the British Rubber Research Board and the British Rubber Publicity Association, both centred in London. This was in 1936 and from these two bodies have developed the present British Rubber Producers' Research Association (B.R.P.R.A.) and British Rubber Development Board (B.R.D.B.).

Originally these two bodies had no formal link with any of the three bodies mentioned under (a), (b) and (c) above. In 1948 B.R.P.R.A. and B.R.D.B. co-operated with the Rubber Research Institute of Malaya (R.R.I.M.) to draw up a five-year plan of research and development. This plan was submitted to the Government and

Headquarters of the Rubber Research Institute of Ceylon at Agalawatta

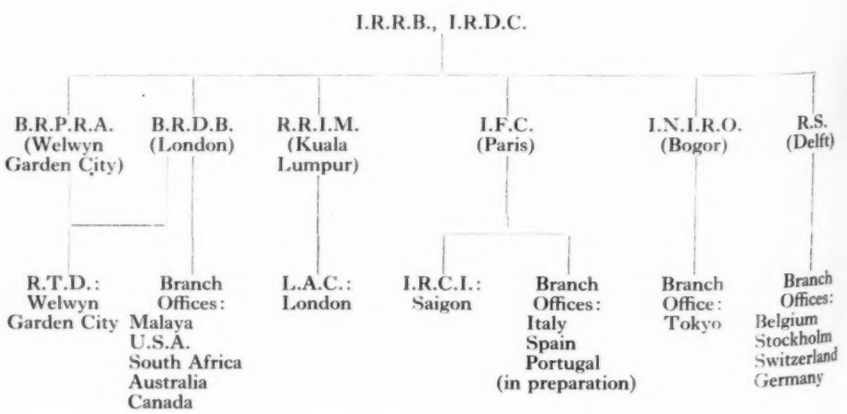
rubber producers of Malaya and resulted in a decision to increase the amount of the cess on rubber exports collected in Malaya so as to provide for an expansion of activities by all three bodies. The cess collected was accumulated in the Malayan Rubber Fund and allocated to the three separate bodies in accordance with the budgets drawn up as part of the five-year plan. This arrangement, while it left the way open for contributions from other British Commonwealth territories to B.R.P.R.A. and B.R.D.B. activities, had the effect of aligning these two bodies much more closely than hitherto with the R.R.I.M. This closer alignment was emphasised in 1951, when the R.R.I.M. became a full member of the international boards.

The change of name already noted, from the British Rubber Publicity Association to the British Rubber Development Board, was made in 1946 and implied a broadening of the scope of this body. At the same time, the B.R.P.R.A. was also extending its activities in the field of technical development and the existence of a field of common interest was recognised in 1951 by the setting up of Rubber Technical Developments Ltd. (R.T.D.). This body is jointly financed and controlled by the B.R.P.R.A. and the B.R.D.B.

Constitution of the I.R.R.B. and I.R.D.C.

Contemporaneously with the establishment of the British Rubber Research Board and the British Rubber Publicity Association, the French and Netherlands Governments set up similar organisations. In each of these cases a single board of management had responsibility for both research and publicity activities.

International co-ordination of effort was provided for by the establishment of the International Rubber Research Board and the International Rubber Development Committee, to which the component national bodies appoint representatives. The present constitution of the international boards is therefore: (from the British Commonwealth) the British Rubber Producers' Research Association, British Rubber Development Board and Rubber Re-

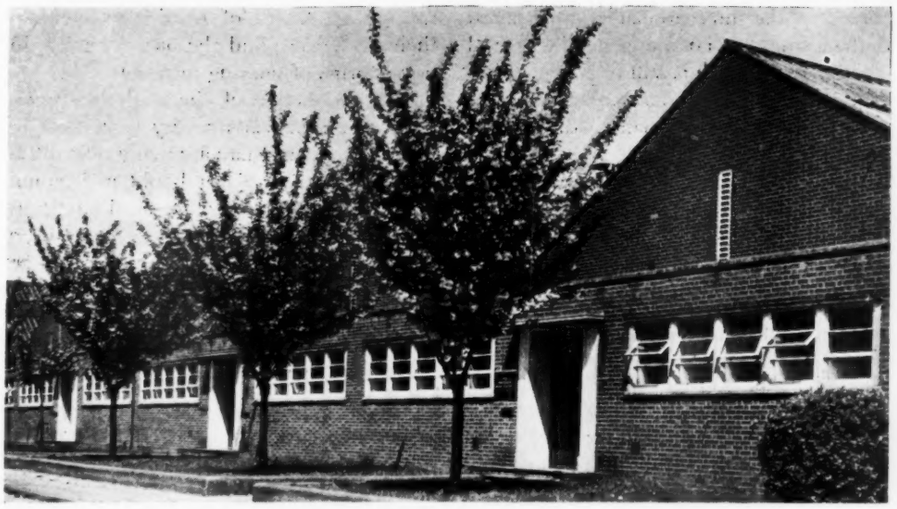


search Institute of Malaya; (from Indonesia) the Indonesian Rubber Research Institute (I.N.I.R.O.); (from the Netherlands) the Rubber-Stichting (R.S.); (from France and associated territories) the Institut Francais du Caoutchouc (I.F.C.) and the Institut des Recherches sur le Caoutchouc en Indochine (I.R.C.I.).

The schematic diagram on p. 182 indicates the general organisation and gives an impression of its world-wide scope.

These international boards have no executive authority over their component members. Their function is purely advisory, but, in fact, a very high level of co-operation has been achieved. Consolidated international programmes of research and development are set up annually and serve the dual purpose of avoiding wasteful overlap of effort and of directing the maximum effort to agreed projects. The full boards, comprising representatives of all the national units, meet annually, with intervening meetings as required of a standing committee. The principal executives of the organisations meet formally twice a year and are in close touch with one another throughout the year on matters of mutual interest and concern. International staff conferences are arranged at approximately annual intervals, but there is a steady exchange of correspondence all the time and fairly frequent opportunities for personal contacts between members of the staffs of the different bodies. There are reciprocal arrangements for exchange of patents and for temporary secondment of staff members for special duties.

For the purposes of publicity and development work the spheres of activities of the several bodies are defined as follows:



Laboratories of the British Rubber Producers' Research Association

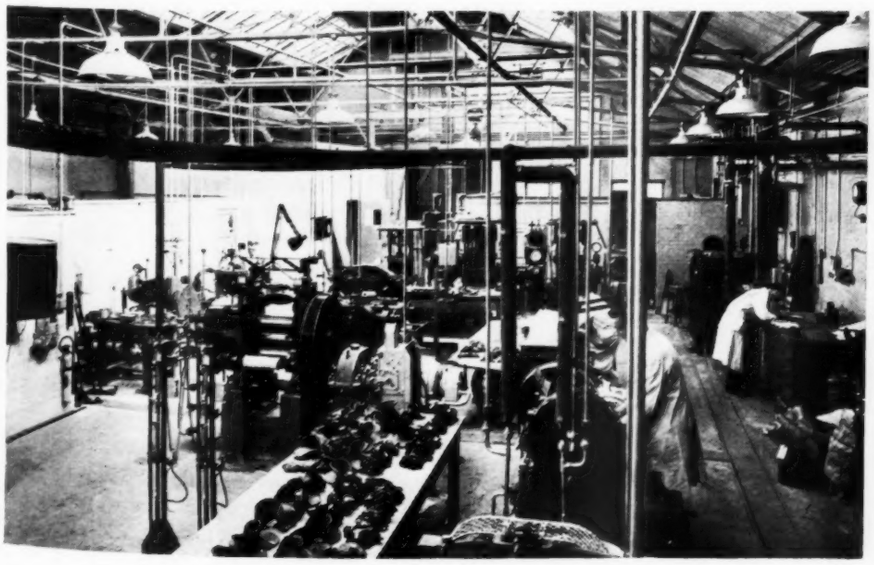
B.R.P.R.A. and B.R.D.B.: British Commonwealth, U.S.A., Burma, Israel, Egypt, Siam.

I.F.C. and I.R.C.I.: France, Israel, Spain, Portugal, Syria and associated States, Lebanon.

I.N.I.R.O. and Rubber-Stichting: Continent of Europe (excluding Latin countries), Latin America, Indonesia, Japan.

Branch offices are maintained in a number of these territories, *e.g.* B.R.D.B. has offices in U.S.A., Malaya, Australia, South Africa and Canada.

The overall scale of activities can be judged from the following figures: In 1951 B.R.P.R.A. expenditure amounted to £133,000; that of B.R.D.B. to £261,000, of which £164,000 represented expenditure on a special publicity campaign in the U.S.A. The budgets of the other bodies are comparable and for 1953 the total budget is of the order of £1,500,000. This may be compared with the sum spent by the Reconstruction Finance Corporation of America on research and development for synthetic rubber, which for the year ended June 30, 1952, amounted to $6,939,476.



General view of the B.R.P.R.A. technological laboratory

Production and consumption research

The work of the research institutes in the producing territories can be roughly classified into production and consumption research. The former is concerned with the factors which influence the growth of the rubber tree, its health and its yield of rubber. The latter concerns the use made of the rubber after it leaves the tree; in practice no precise line of demarcation can be drawn between the two classes.

The production research and development activities include the development of new planting materials with the object of increasing yields, reducing costs and improving quality. For this purpose the Eastern research institutes maintain their own estates. In addition to experimental work of this kind, a great deal of advisory work for the rubber producers of the territory is also undertaken. Indeed, a substantial part of the budget of each of the Eastern research institutes is devoted to general service to the smallholders and the solution of *ad hoc* problems submitted by producers.

On the border line between production and consumption research is the recent development of technically classified natural rubber. This represents an attempt to provide the consumers of natural rubber with information as to its technical properties and probable behaviour in the factory. Co-operation among all the institutes in-

cluded in the international group has led to the introduction of a scheme of technical classification, which is still in course of development, but which has already received a warm welcome from manufacturers.

Research arising out of present uses of rubber

Turning now to consumption research, a considerable part of the total effort of the producers' research organisations is directed towards maintaining the present position of natural rubber against the competitive threat of synthetics. The evolution of a series of synthetic rubbers has challenged sharply the use of natural rubber in a number of fields. While these synthetics are broadly similar in general properties to natural rubber and to one another, they all have their individual singularities, which have in some cases enabled them largely to displace natural rubber from a limited field. Butyl rubber, for example, although distinctly inferior in elasticity to natural rubber, shows outstandingly low permeability to air and for this reason is now widely used in the construction of inner tubes.

The defence of natural rubber against such a challenge must rest on the dual basis of the price and quality of the article made from it. Researches designed to enable the quality of natural rubber articles to be improved have been and are being pursued on a wide front. The British Rubber Producers' Research Association in particular has taken the view that a fundamental investigation of the physics and chemistry of rubber is a very necessary preliminary to technological work. The various institutes have studied the properties of rubber hydrocarbon as it is obtained from the tree and the chemical reactions involved in its vulcanisation and its ageing. A substantial body of new knowledge has been accumulated and forms the basis for technological advance. A policy of free publication puts this new scientific knowledge at the disposal of rubber manufacturers throughout the world.

Development of new uses

The other main part of the collective plan of the producers' research and development organisations is the expansion of the overall market for natural rubber by the development of new uses. These again fall into two categories, dependent on whether the rubber is used as such or in the form of chemical derivatives. In the former category may be mentioned the addition of rubber powder to bitumen for use in road construction, the use of latex for the treatment of textiles to improve their properties, and the use of rubber in novel forms of flooring material.

The production of chemical derivatives of rubber represents a very large field in which, however, there are many difficulties to be overcome. Natural rubber does not lend itself too readily to chemical modification, but practical processes have been developed in which the rubber may be solid, dissolved, or in the form of latex. Products obtained by such processes have essentially lost their rubber-like properties and are more appropriately classed as plastics. Among such products which have long been in commercial use may be mentioned rubber hydrochloride and chlorinated rubber. Recent work has brought other materials within sight of commercial exploitation. Applications envisaged include materials for flooring, for shoe soling and for paint bases.

Publicity and development

The work of the research organisations merges continuously into the field of development, which is also approached from the other side by activities which may be described as publicity. The general aim of this field of activity is the encouragement of both old and new applications of rubber by a variety of methods in which various forms of publicity play an important part. These are in many cases educative in nature and include the production and distribution of films and the publication of several periodicals as well as technical notes and reports. Illustrative of this type of work is the publication by the British Rubber Development Board of the periodical *Rubber Developments* and of a series of technical booklets, including *Rubber in Aircraft*, *Rubber in Mining*, etc. In France and Holland the training of rubber technologists is undertaken by the natural rubber producers' organisations. In England this work is the duty of the National College of Rubber Technology and the rubber schools, but B.R.P.R.A. and B.R.D.B. have been able to assist by provision of special lectures and by appointments to the governing bodies.

Agricultural (Poisonous Substances) Act

It has been announced that regulations under the Agriculture (Poisonous Substances) Act, 1952, have been made by the Minister of Agriculture and Fisheries and the Secretary of State for Scotland for the purpose of protecting employees against risks of poisoning from the dinitro and organo-phosphorus compounds now extensively used in agriculture and horticulture for the control of weeds and pests.

The regulations came into operation on March 31, 1953. They apply to the following weedkillers and insecticides: DNC, Dinoseb, Parathion, Schradan, Dimefox, Mipafox and TEPP (HETP).

They have been made after consultation with the representative organisations concerned and many of the requirements are based on experience obtained during 1951 and 1952, when schemes of voluntary precautions were operated by the Agricultural Departments with the co-operation of these organisations.

The regulations

The regulations prohibit the use of the dinitro and organo-phosphorus compounds in agriculture and horticulture unless the employees working with them are wearing protective clothing. The protective clothing to be worn varies according to the particular operation being carried out. For example, when mixing it consists of rubber gloves, rubber boots, face shield and either an overall and rubber apron or a mackintosh; spraying ground crops in the open requires overall, hood, rubber gloves, rubber boots and face shield; and wet spraying in a greenhouse requires rubber gloves, rubber boots, hood, face shield and either an overall or a mackintosh. The regulations restrict the number of hours during which workers can be employed on work with the poisonous substances, for example, not more than 10 hours can be worked in any one day, and prohibit the employment on this work of any workers under the age of 18. The regulations do not apply to the self-employed man.

Protective clothing

The regulations also contain requirements as to the provision and maintenance of protective clothing, the provision of washing facilities for workers, the notification of sickness and of absence, the training and supervision of workers, the keeping of registers and other matters.

The Agricultural Departments are issuing a leaflet summarising the main provisions of the regulations and setting out a number of additional recommended precautions.

In November 1950, WORLD CROPS published an article by Dr. W. E. Ripper outlining the dangers which could result from careless handling of certain toxic sprays and recommending the preventive measures to be taken. The Bill was first introduced to parliament in March 1952.

Rubber Latex as a Raw Material for Industry

G. MARTIN, B.Sc., F.I.R.I.
London Advisory Committee for Rubber Research

The bulk of the plantation rubber of commerce comes onto the market in the form of different types of rubber sheet. A growing amount, however, is marketed as preserved latex, the form in which it is extracted from the tree. For certain purposes latex has pronounced advantages over sheet rubber, and the demand for it has steadily expanded during the past 30 years. In this article, Mr. G. Martin discusses the uses and future of the product.

THE basic raw material of the rubber manufacturing industry in the U.K. is the rubber hydrocarbon synthesised by the rubber tree, *Hevea brasiliensis*, which is cultivated on a large scale in Malaya, Ceylon, Java, Sumatra and Indo-China. Alternatively, elastic raw materials are made from oil and coal, chiefly in the U.S.A. and Canada, but no one has yet succeeded in synthesising a product identical with, or as elastic as, the natural rubber hydrocarbon, whose method of formation is still a secret, hidden in a maze of complex living processes, which occur not only in the rubber tree, but also in many other plants which produce small quantities of rubber.

Latex

The rubber of *Hevea brasiliensis* is found mostly in the bark, where it occurs as a milky fluid containing microscopic particles of rubber dispersed in a watery solution in vessels which form a continuous network round the tree. When the bark is cut the milky fluid, known as latex, emerges drop by drop and continues to flow for some time. As its name implies, rubber latex has the appearance of milk, but there the resemblance ceases, except that both contain large quantities of microscopic particles in water. In milk they consist of fat as compared with rubber in latex.

As it issues from the tree, latex contains about 30% rubber with minor quantities of a complex assortment of mineral salts, fats, proteins and sugars. It is, therefore, an excellent medium for the growth of bacteria, which, at tropical temperature, multiply at a tremendous rate. Acids and enzymes are formed; the latex soon begins to smell and the rubber to coagulate. With care the latex remains fresh and sweet for a few hours, but a suitable preservative must be added in adequate amount if the latex is to be kept in a liquid condition for a long period.

Rubber from latex

To prepare clean, dry rubber free from fermentation a small quantity of weak acid is added to the latex as soon as is practicable and before fermentation has had much opportunity to develop. The rubber separates slowly overnight as a spongy gel, which is lightly mangled in the form of a sheet and then dried in smoke from waste firewood, which also acts as a disinfectant.

A workman in a United States rubber manufacturing plant watches as foam rubber made from natural latex flows into a mattress mould

Raw rubber is mostly marketed in the form of smoked sheet compacted into bales weighing about 2 cwt. By the time that the bales reach a rubber factory they are usually hard, tough and often literally 'frozen' stiff. To make a manufactured article the rubber has to be 'thawed,' mechanically worked until it is reasonably soft, mixed with useful compounding ingredients, forced into various shapes and then vulcanised. The large-scale production of the simplest article requires heavy and expensive equipment and a considerable amount of power.

Latex as a raw material

Because latex is a liquid, it can be converted into manufactured articles with only light equipment and a small amount of power. The idea of using liquid latex instead of dry rubber as the raw material of the rubber manufacturing industry is obviously an attractive one, but only during the last 30 years has it made any progress.

Long before rubber was known in Europe, Indians in South and Central America made footwear and playballs from latex obtained from native sources. The articles were undoubtedly crude by modern standards and were not vulcanised, but they were probably better than most people imagine. One of the writer's treasured curios is a light, hollow ball made from latex by a 10-year-old native boy whose only equipment was his fingers.

Although Hancock discovered and developed the art of manipulating dry rubber over 100 years ago, he appreciated the advantages of production from latex and obtained patents for making a wide range of articles from imported latex. The technical difficulties were, however, too great

and commercial development failed to mature.

At that time there were no rubber plantations and imported latex had to be obtained from miscellaneous botanical sources without concentration and without much experience of what was required for satisfactory preservation. Not until after the first world war was there available a potential source of a large supply of latex of reasonably reliable quality. Interest in the direct use of latex soon became very active and highly competitive attempts were made in Europe and America to obtain control of the market by discovering and patenting methods of preserving, concentrating and using latex. The success of these efforts may be judged by the fact that in 1920 the market in liquid latex did not exist; in 1930 world exports amounted to over 5,000 tons of rubber in the form of latex; in 1940 they had reached nearly 45,000 tons, and in 1950 they were about 90,000 tons.

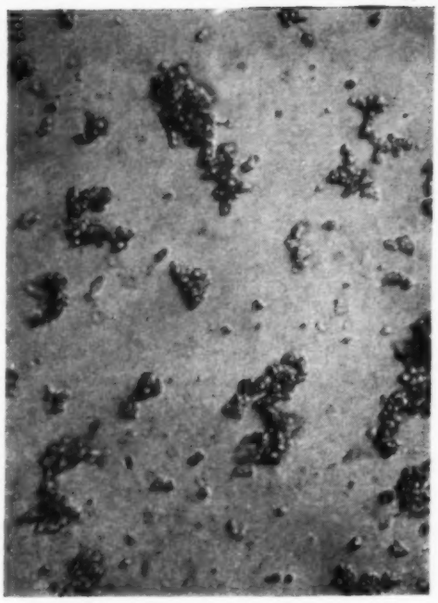
The extraordinary feature of this development is that most of the articles made from dry rubber 30 years ago are still made in this way and the bulk of the demand for latex is for the manufacture of articles not previously produced.

Latex sponge

An outstanding example of such a development is the manufacture of sponge rubber by frothing latex, which is then set, vulcanised and dried. Types of sponge are also made from dry rubber, but none has the same structure and serves the same purpose as the open-cell type of sponge made from latex. In the course of a few years latex sponge has achieved such immense popularity as a cushioning material in the furniture trade that it is now responsible for more than half the world's consumption of latex. Moreover, there is little doubt that this is only the beginning. Competition is increasing on both sides of the Atlantic and methods of manufacture are being improved. In the opinion of some enthusiasts there are prospects that the market for latex sponge will eventually be nearly as important as that for tyres, which now consume about 70% of the world production of rubbery materials.

Latex cement

A second example of a major use of latex, with possibilities of an extending market, is the product obtained by mixing latex with hydraulic cement. Although the mixture sets hard like cement, it has important advantages not possessed by either rubber or cement alone and is finding extensive outlets in the shipbuilding and building industries. It adheres well to metals, is chemically more inert than similar types of



Micro-photograph showing clusters of rubber particles in creamed latex

flooring from other materials and is non-slippery, an important advantage for ship's decks.

Rubber thread made from latex is much finer than anything produced from dry rubber and has extended the use of rubber in the garment trade. To force dry rubber through minute orifices would require high temperatures and extraordinarily powerful equipment, but latex only requires the force of gravity.

Latex as an adhesive

As an adhesive latex has only to be spread on the surfaces to be joined together, but dry rubber has first to be plasticised and then dissolved in an organic solvent, often with considerable fire risk, to make a satisfactory rubber solution. Here again, however, the adhesive properties of latex are such that it cannot usually replace rubber solution, but has opened up new markets for rubber as an adhesive, chiefly in the shoe industry.

Other uses

Latex is also finding considerable use as a binding material for waste products. For example, reconstituted leather is in some respects better than leather itself. With the help of latex excellent hardboards with various uses in the building trade are being made from cork, sawdust, wood flour, and waste sisal, cotton and jute.

The advantages of foamed latex sponge for carpet underlays are self-evident. Latex is also used to provide a thin backing of rubber to carpets so as to prevent them from slipping on polished floors.

Ebonite is rubber which has been vulcanised with large quantities of sulphur until it is hard. An unusual but important use of latex is in the manufacture of microporous ebonite battery separators.

Expanding demands

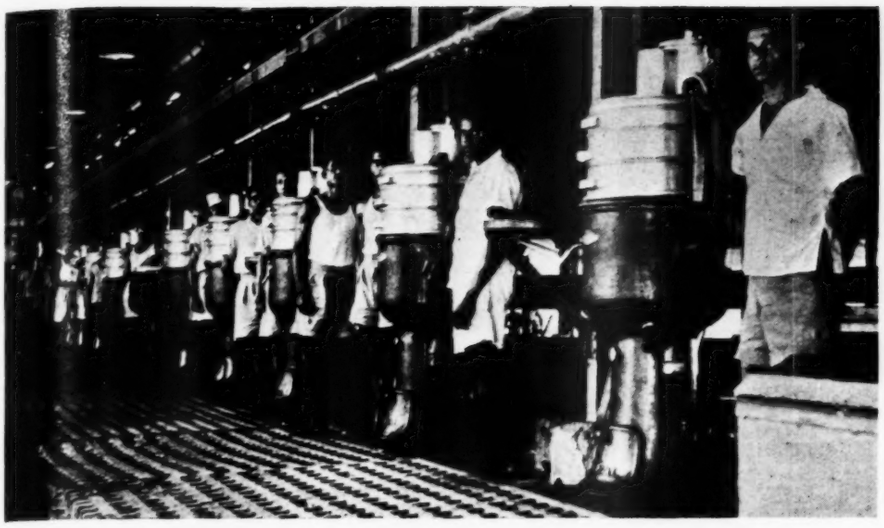
Most of the new uses based on latex are so intimately associated with the comforts of civilisation that the prospect of an expanding market can be envisaged with confidence. In addition, there are possibilities of further new uses which may surpass in importance most of those so far mentioned. Mixtures of rubber and bitumen are stated to have advantages over bitumen alone for road surfacing. In so far as the improved properties are dependent upon a solution of rubber in bitumen or upon its distribution as a fine dispersion, latex is far more convenient as a raw material than sheet rubber. Without special treatment the latter is difficult to dissolve even in a good organic solvent. Moreover, rubber in latex is not degraded and is therefore more potent in its effect on bitumen than plasticised, dry rubber.

In spite of these remarkable developments, the consumption of natural rubber in the form of latex is only about 5% to 6% of the total production. It is obvious, therefore, that the apparent advantages of latex over dry rubber as a raw material have had little effect on the bulk of rubber manufacture. It is true that balloons, gloves and most dipped goods are now made from latex instead of from rubber solution and that latex tends to replace solutions for coating fabrics and that some small moulded articles are made from latex, but rubber manufacture is still mostly based on dry rubber and is likely to continue along these lines.

Preparation of latex

There are many reasons why latex has failed to make substantial inroads into the demand for dry rubber, and the first, and probably most important, is the cost of latex when used as a raw material. This may seem surprising because dry rubber is prepared from latex, but the cost of preparing and transporting dry rubber is distinctly less than the cost of preserving, concentrating and transporting latex.

The usual preservative is ammonia, which not only neutralises acids formed by bacterial decomposition, but, when added in sufficient amount, keeps the latex sterile and increases the repulsive forces between the rubber particles. The ammonia has to be added without delay, because acid formation, even when insufficient to cause coagulation, has an adverse effect on the utilisation of latex by manufacturers. The amount required for complete sterility is



Battery of centrifuges for separating rubber from natural latex

nearly 2% of the water present, but in the interests of economy and technical control the full amount is not added until the latex has been concentrated.

Concentration

Latex is concentrated in order to save part of the cost of transporting water and also to give consumers reasonable latitude in adding vulcanising ingredients finely dispersed in water. Four methods of concentration are in commercial use. Three depend on some method of creaming to effect a physical separation of more than half the aqueous serum. These processes therefore involve purification as well as concentration. The fourth method consists in the partial evaporation of the water present and so the concentrate includes all the serum substances as well as soaps and fixed alkali added to prevent coagulation during preparation. Most latex is concentrated by creaming, but the evaporated concentrate has advantages for some purposes.

Creaming

Rubber particles are lighter than water and tend to rise if the latex is left undisturbed for a long period, but, owing to Brownian movement the particles are never still and this prevents a clear-cut separation of cream and serum. For commercial concentration it is therefore necessary to increase the force of separation greatly in excess of gravity or to cause the particles to form loose, reversible clusters which rise much more rapidly than individual particles. The increase in the force of separation is produced by centrifuging and the clustering of the particles by the addition of chemicals known as creaming agents or by reversible electric currents which deposit the charged particles on a diaphragm and then remove them as loose clusters.

Centrifuging

Concentration by centrifuging was the first commercial process and is still the most popular. The apparatus used is similar to a milk centrifuge and effects a continuous separation of cream containing 60% rubber and dilute latex, *i.e.* skim containing 5% or more rubber. As large particles separate more easily than small ones, this type of concentrate differs from the others because of the proportion of large particles which it contains, but there is no evidence that this has an important effect on the suitability of the concentrate for manufacturing purposes. The skim contains mostly very small particles which are difficult to coagulate. The disposal of skim is a problem which adds to the cost of the centrifuging process.

Chemical creaming

Chemical creaming agents are hemicelluloses, pectins and alginates, which are abundant in vegetable products and have the property of forming very viscous solutions in water. Various gums and extracts of seeds, etc., have been used, but the most popular material on account of purity, effectiveness and price is ammonium alginate prepared from seaweed. Only about 0.2% of the water in the latex is required to cause the rubber particles to form clusters of various sizes containing, in some cases, thousands of particles. The cause of clustering is not well established, but it is evidently connected with the affinity of the creaming agent for water. The particles which form a cluster do not fuse together, but retain their identity and separate again on dilution or temporarily on stirring. The amount of creaming agent added is not sufficient to have an important effect on the fluidity of the latex and in the course of 24 hours a cream is obtained containing nearly 60% rubber with a sharp separation of almost clear serum in the lower layer. By allowing the latex to remain undisturbed for a period of weeks a concentration of over 65% rubber is obtained in the cream, and this is commercially and technically preferable to lower concentrations, which exhibit a marked tendency to continue creaming during transit and so cause difficulties due to lack of uniformity.

Electrical creaming

The electrical creaming process is relatively new and only a few commercial shipments have been made. It has the advantage that the loss of rubber is small compared with that in the skim of centrifuged latex, and it contains no added chemical which can give rise to 'after creaming,' as can happen in chemically creamed latex. The concentrate contains about 60% rubber and is of a high standard of purity and stability.

Evaporation

The evaporation process is simple in principle, but requires suitably designed equipment to avoid coagulation due to overheating or too rapid evaporation from the surface. The latex is concentrated until it contains about 70% rubber and is therefore a thicker cream than the other concentrates. It is remarkably stable because of the stabilisers added. Most concentrated latices can be easily coagulated by rubbing a small quantity on the hand for a few seconds, but evaporated latex can be rubbed for a very long period and tends to coagulate eventually by drying.

The preservation and concentration of latex require far more care, skill and control than does the preparation of dry rubber. Moreover, dry rubber is usually transported without packing materials, whereas latex has to be shipped in drums or specially constructed ships' tanks. Freight charges for rubber are based on the space occupied and the rubber sheets are therefore compressed together to avoid paying for air space. In the case of latex, water has to be transported and paid for as well as rubber.

Latex and dry rubber

The difference between the price of rubber as such and as latex depends on supply and demand. For short periods when the demand for latex has not kept pace with supply there has been no difference in price despite the extra cost of rubber as latex. Usually, however, there is an appreciable premium for rubber in latex, amounting to several pence per pound.

One of America's huge synthetic rubber plants. This one is in West Virginia

Such a difference in price is sufficient in itself to eliminate the possibility of direct competition between dry rubber and latex.

There are also sound technical reasons why latex is not likely to encroach on the dry rubber market and similar reasons explain why natural rubber latex at present has less to fear than dry rubber from the competition of synthetic materials. These reasons are connected with the intricacies of rubber technology, some of which even experts find it difficult to explain.

Natural rubber is very strong because on stretching the molecules tend to align themselves and take up fixed positions relative to each other, such as occurs in all crystalline materials. The molecules of most synthetic rubbers are not so regular in shape; they cannot align themselves so easily on stretching and the rubber is relatively weak. To obtain a strong general-purpose synthetic rubber product, the basic material has to be mixed very intimately with a toughening or reinforcing agent, such as carbon black. Although the rubber particles in latex are microscopic in size, each consists of thousands of molecules, and when carbon black is dispersed in latex it remains outside each group of molecules and acts merely as a diluent. In other words, carbon black strengthens and toughens articles made from dry natural and synthetic rubber, but weakens articles made from latex. By itself synthetic rubber is weak. Consequently articles made from general-purpose synthetic rubber latex are lacking in strength. It is usual, however, in U.S.A. to dilute natural rubber latex with synthetic rubber latex and in this way obtain an article of satisfactory strength.

Without carbon black even natural rubber is too soft for such an article as a tyre tread. Although natural rubber is inherently strong without carbon black or other reinforcing material, it stretches too easily for most purposes and so gives rise to excessive local strains. An intimate mixture of rubber and carbon black is essential for toughness and resistance to abrasion and such an intimate mixture cannot be obtained directly from latex. The carbon black and dry rubber have to be kneaded together between powerful rolls to produce a satisfactory product. It is evident, therefore, that the complete replacement of dry rubber by latex in the manufacture of tyres and many other articles is not technically sound.

Another reason why latex processes are not likely to compete with dry rubber is the difficulty of drying thick articles. On coagulation most of the water in latex may drain off quickly, but as the coagulum dries it becomes somewhat impermeable and there remains at least 10% of water, which is difficult to remove, particularly from thick articles. Moreover, during drying the coagulum shrinks in volume, making it difficult to control shape and dimensions.

WORLD CROPS—Change of Address

Last year the offices of WORLD CROPS moved to a new address which is as follows:

Stratford House,
9 Eden Street,
London, N.W.1.

However, a considerable amount of correspondence is still sent to the old address at 17 Stratford Place, London, W.1, resulting in delay in answering letters.

Readers are asked to make certain that our old address on their records has been cancelled and the new one substituted for it.

The future of latex

For these reasons the use of latex for the manufacture of rubber articles is likely to be confined to thin-walled products where drying is quick and ease of deformation is an advantage, *e.g.* sponge upholstery, dipped goods, etc. Latex is also suitable for the manufacture of cheap, thick articles where strength is unimportant and which can be heavily loaded to facilitate drying. Nevertheless, attempts are being made to toughen the rubber in latex without carbon black. A French process now being developed consists in linking the rubber molecules with a phenol-formaldehyde resin. Tyre treads made from such a reinforced latex are stated to have given satisfactory results.

In the opinion of the writer, this and similar developments may open up new markets for latex if they result in the production of products which cannot be made from dry rubber. For the manufacture of established products, latex is too expensive to become a serious competitor. For the present the future of latex is largely dependent on the extension of existing markets. A handicap to rapid expansion is its sensitivity to small changes in conditions, which make it a somewhat treacherous material to process. In addition, supplies from different sources may exhibit unfortunate differences in properties, which not only hinder production, but sometimes lead to appreciable waste of expensive material. The causes of these difficulties are being slowly elucidated and it is becoming more fully appreciated that, although the manufacture of latex articles bears some resemblance to a kitchen type of industry, commercial success is impossible without strict scientific control at every stage from the plantation to the finished product.

Photos: Pp. 185 and 188, U.S.I.S.

The Rubber Research Institute of Malaya

C. E. T. MANN, M.Sc., F.I.R.I.
Director, the Rubber Research Institute of Malaya

The Rubber Research Institute of Malaya is the largest research institution concerned with any one crop product in any of the overseas dependencies of Great Britain or any other tropical country. It is located in Kuala Lumpur, housed in modern laboratories with the latest scientific equipment and employs a large staff of trained scientific officers. This account of the Institute has been specially written for WORLD CROPS *by its Director, Mr. C. E. T. Mann.*

THE Rubber Research Institute of Malaya was established in 1925 for the purpose of harnessing the sciences to the rubber-growing industry of Malaya for its economic betterment. The greater part of its effort has been applied research and advisory service to the rubber estates and smallholdings. In 1937 new offices and laboratories were occupied near Kuala Lumpur and with a full staff and adequate equipment the vessel of research got truly under way.

Research organisation

Investigations are under four Divisions, Soils, Botanical, Pathological and Chemical, to give them in some logical order. They are housed, together with an administration block and library, around a central courtyard. Last year, 1952, those divisions could look back with pride to 25 years' fine accomplishment despite the setbacks of economic retrenchment and Japanese occupation.

The Soils Division is concerned with the environment in which the rubber tree is grown, including study of cover crops, weed control and manuring. The plant itself, *Hevea brasiliensis*, is the concern of the Botanical Division, who study the many factors affecting the production of latex and carry out the improvement of planting material by breeding and selection.

Our tree now established in its proper environment, its well-being is the concern of the Pathological Division, who find the means to combat not only diseases of leaf, bark and root, but the depredations of insects and animals, from white ants to elephants. Finally, the product, latex, is studied by the Chemical Division. A Statistics Section serves all the divisions, particularly in the design of experiments, and there is a library housing some 12,000 volumes.

Rubber trees of three ages on the R.R.I. Experiment Station at Sungei Buloh. They are 20 years, 3 years, and just under 1 year old respectively.

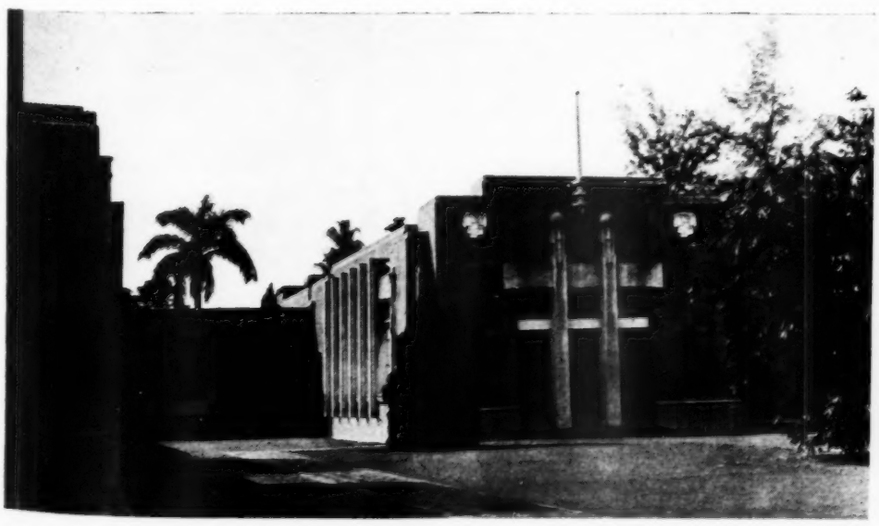
Experiment station

The experiment station of the Rubber Research Institute is some 17 miles from Kuala Lumpur and occupies over 2,000 acres. It is here that most of the Institute's field experiments are laid down. A factory is equipped to produce every marketable form of rubber, from crepe to creamed latex, and has facilities for setting up pilot plant for new forms to be developed.

Advisory service

After research advisory service is the other important function of the Institute. Every rubber planter in the country can call upon the Institute for advice, whether for estate or smallholding. The Institute is not a Government department, but is paid for out of a cess levied on all rubber produced and exported from Malaya. To ensure stability—and rubber has ridden stormy economic seas—the income of the R.R.I. has been guaranteed by the Government of the Federation over the period 1949-53 to permit a five-year plan of research to be made and followed. To date the cess has been sufficient to provide a sound basis for carrying out a balanced programme of investigation after recovery from the Japanese occupation. With the fruits of this effort the Institute will be in a position to give still better advisory service to the rubber producers of Malaya, who provide the funds. This service is organised so that nothing comes between the research officer and the plantation.

No details can be given here of the work of the Institute, but some indications are given in other articles in this issue on the



The courtyard of the R.R.I., a corner behind the administrative block, showing the library exit

effort to improve yields and on the problems of the smallholders, who produce nearly half Malaya's rubber.

Not only is general improvement the aim, but insurance against calamity, economic or natural. Thus much has been done to be ready should the dread South American leaf blight invade Malaya; this was the disease which ruined so many schemes for establishing rubber plantations in South and Central Americas. The threat from synthetic rubber has brought about a healthy spirit of competition and increased attention to the finished product. For this reason, although the need for 'rubber to specification' presents the greatest problems to the Chemical Division, all divisions have common studies on which they work in harmony, and the finished product is ever the goal in view, qualitatively as well as quantitatively.

Rubber Smallholders—Problems and Progress

L. R. DAVIDSON, B.Sc. (Agric.)

Smallholders' Advisory Officer, Rubber Research Institute of Malaya

Rubber in Malaya is produced on plantations ranging from less than one acre to several thousand acres. This article is concerned with the rubber smallholders—a class of peasant agriculturists operating holdings of, on the average, three to five acres. The great majority of smallholders own less than 25 acres, but official statistics generally include as smallholdings all plantations of less than 100 acres. A little more than 40% of Malayan rubber is produced on holdings in this category and about four-fifths of this probably comes from holdings of less than 25 acres.

Young rubber rootstocks on the R.R.I. Experiment Station. These have been budgrafted, at the foot of the tree, with high-yielding material

THE extraction of latex from the trees is the most important step in rubber production, and the method of harvesting is basically the same on all sizes of plantation.

The best output per worker and per acre is generally obtained when trees are tapped on half circumference every other day, and with good tapping little more than $\frac{3}{4}$ in. of bark will be removed each month.

Malay smallholders, possibly because of the limited areas of their holdings, generally tap their trees every day except when bad weather, holidays or the need to attend to other crops prevent them. Though they may tap on less than half the circumference of their trees their tapping cycle is generally shorter than eight years, often less than six, and they are therefore tapping thin, incompletely renewed bark which is easily wounded. In order to extend the tapping cycle they frequently tap high up the trunk where the yield is considerably lower than near the base.

Before the Japanese invasion of Malaya, experienced observers have generally been unfavourably impressed by the appearance of tapping panels on smallholders' trees and the poor reserves of bark which would be considered tappable under good management on the large plantations. Even after years of restricted production the picture of smallholdings as over-tapped senescent rubber facing inevitable decline in production was generally agreed and the need for eventual replacement of the old trees was accepted. The enforced rest of the Japanese occupation provided a respite to smallholders' rubber; now, seven years after production was resumed and after a period of excessive tapping resulting from the high prices reached in 1950 and 1951, the urgent problem of the replanting of smallholders' areas must be faced without delay.

Processing

In the processing of rubber the final products of estates and smallholdings are often contrasted. The requirements for the manufacture of good smoked sheet rubber are basically simple, and they are readily adopted by estate factories. Where large quantities of rubber are handled in one place the smooth flow of rubber from the field through factory to smoke-house and packing sheds is a simple matter of organisation and a uniform sheet of good quality should be obtained without difficulty. Smallholders or their tappers handle small quantities of rubber individually. They therefore tend to hurry certain stages of the preparation which require time.

The rubber dealer presented with incompletely cured rubber is buying an unknown quality and will pay accordingly. Under such circumstances, therefore, the smallholder has to accept what he is offered and there is little incentive to improve his processing methods.

Technical assistance

Fundamentally the methods of harvesting and processing raw rubber have changed little during the evolution of the rubber plantation industry. Refinements have, of course, been developed to obtain the best return from labour, land and trees, while mechanisation has been increasingly applied to factory work to keep costs low.

The need to make information on technical progress available to smallholders was acknowledged with the formation of the Smallholders' Advisory Service

of the Rubber Research Institute in 1934. The ideal field officer for this service was available from the Malayan born, English-speaking men of Malay, Chinese and Indian nationalities who had completed the three-year diploma course of the College of Agriculture at Serdang.

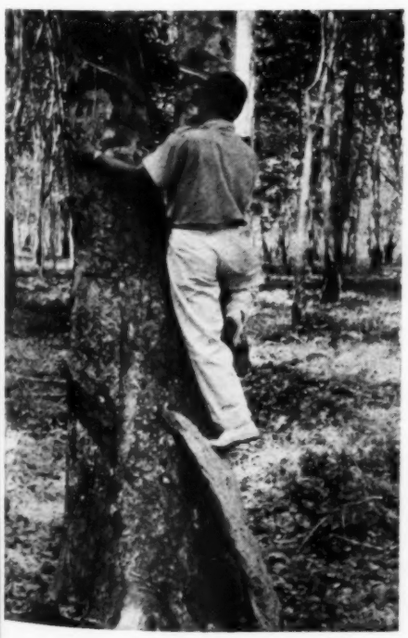
Economic difficulties

The early efforts of our rubber instructors had naturally been directed to the most urgent tasks of improving the smallholders' methods of tapping and the maintenance of his rubber areas. The difficulties encountered by rubber instructors, and the information which they have accumulated on the general pattern of smallholders' practices, have demonstrated clearly that economic factors as well as technical difficulties are responsible for the relatively slow response to the advice that can be given to them.

General poverty and lack of thrift amongst Malayan smallholders result in rubber-producing equipment being purchased on the basis of cheapness, and little attention is paid to probable length of life, ease of use or effect on quality. Much inefficient material is therefore used which involves waste of effort and results in a part finished rubber of inferior standard.

Size of holding

In every field of work on smallholdings it seems likely that better methods would be more readily adopted if holdings were considerably bigger than at present. Land for rubber cultivation by smallholders has generally been alienated in lots of from three to five acres. Units of this size are perhaps quite suitable for padi cultivation or for fruit cropping.



An example of high tapping of old seedling rubber on a smallholding

Well maintained old seedling rubber on a smallholding in a coastal district

But for rubber growing they are not well suited and the minimum size of unit for efficient rubber cultivation might well be determined by two main considerations. An adult can tap each day about 400 rubber trees, and since tapping should be done not oftener than every alternate day, he requires at least 800 trees or, in terms of acreage under good husbandry, six to eight acres of mature rubber to provide him with reasonable full-time employment as well as an adequate income. In addition, the need for progressive replacement of obsolescent trees requires that allowance should be made for one-quarter of any rubber area to be out of production at any time. Thus alienation of land to provide for ten acres of rubber land for each holding would make it comparatively simple for smallholders to adopt the planting and harvesting techniques which have proved most satisfactory on large estates, and sufficient land for the cultivation of food and other short-term crops would always be available.

Replanting

Over two-thirds of smallholders' rubber is reckoned to be over 30 years' old, and the need for increased replanting and the use of improved high-yielding planting materials on smallholdings have been fully recognised for a long period. Both before and since World War II steps have been taken to ensure that supplies of good material have always been available to meet any smallholders' requirements. The supply of planting material has not in itself been sufficient to induce replanting however, and progress has been relatively slow. Of the 20,000 acres which have been replanted on smallholdings between 1945 and the end of 1952, approximately half has been on areas reported to have been felled during the Japanese occupation and only on about 10,000 acres, or less than 1% of the total acreage, have smallholders been prepared to fell the existing rubber trees in order to replant.

The reasons why smallholders have been unable to undertake replanting more widely are almost all related to livelihood and size of holding. The smallest area which can reasonably be replanted in the midst of mature rubber is one acre, and even in one acre the marginal area in which growth of young plants will be restricted by the shade of adjacent rubber and by root competition is an unsatisfactorily high proportion of the replanting.

One acre is more than one-fourth of the average holding and few smallholders dependent mainly on their land for a living can afford to give up this proportion of income at the same time as they undertake the heavy work which will give no immediate return.

Near towns rubber trees have been sold for firewood at prices which have more than compensated for the work of preparing and replanting the land. Again, on fertile soils profitable short-term crops can be grown for a period between the young rubber plants. In one area the value of catch crops, such as tobacco, water melon, tapioca and banana have been considered by Chinese growers to justify adoption of an avenue system of planting with rows 40 or 45 ft. apart and the trees 6 to 8 ft. apart in the rows. The avenue system, in con-

trast with square or rectangular planting, extends the time during which crops can be cultivated between the rows to perhaps four years because of the slower development of complete overhead shade. Taken a step further, the avenue system of planting develops into hedge planting where close-planted rubber rows 50 to 70 ft. apart allow inter-crops to grow unshaded for even longer periods. The economics of such systems of husbandry require considerable further investigation.

In any event rubber has been the principal interest of many Malayan smallholders for 40 years, and there remain large areas of the country where only rubber has been shown to grow satisfactorily. In such areas land must be replanted with rubber alone and the land maintained with consideration only for the optimum growth of the rubber trees.

The replanting scheme

The need for smallholders' rubber to be replanted rapidly and steadily is now to be met by a scheme sponsored by the Rubber Producers' Council of the Federation of Malaya. An organisation is being established with the necessary authority and finance to secure replanting by grants which will recompense the smallholder for work undertaken and meet the cost of necessary materials. Smallholders will still have to face the loss of income from their old trees until the new plantings reach production, but the realisation that their revenue is rapidly declining should encourage them to secure their livelihood, during the period of immaturity, from alternative employment including, where possible, the growing of other crops amongst the young rubber trees.

In initiating this replanting scheme the authors clearly recognise the recurrent need for replanting rubber trees. The immediate aim is the replanting of 500,000 acres of approximately one-third of the Malayan smallholders' acreage during a period of seven years. This, however, will only be a beginning and so long as natural rubber remains a profitable crop, replanting at an annual rate of about 3% of the rubber acreage will be a continuing necessity.

Quality of raw rubber

Replanting is not, however, the only problem in smallholders' rubber production, nor is it perhaps the greatest and most pressing. The practice of smoking sheet rubber before sale requires adoption by all producers if they are to obtain the price encouragement necessary for improved quality. This requires co-operation between smallholders and, without doubt, the gain is enhanced by economy of labour and improvement in technique if the joint action is extended to the treatment of latex.

There is an even more important argument for the development of central processing of smallholders' rubber in the present competition which the natural rubber industry is facing from synthetic rubbers. The defence of natural rubber appears to be in greater uniformity of the raw material supplied to manufacturers, in labelling variations where these can be measured and in the provision of special products to meet particular consumer requirements. Prospects for the future suggest that large district central factories capable of making a variety of products are required if smallholders are to reap their due share of benefits arising from new developments in processing.

Centralised manufacture

Experience during the past five years of a variety of organisations for the processing of smallholders' latex have emphasised the difficulty of establishing co-operative manufacturing and marketing societies except in small-scale undertakings. The most successful ventures have been developed by enterprising individuals, usually rubber dealers, who have combined a good business sense with a willingness to accept advice on technical matters.

The small co-operative organisations for processing and marketing generally handle the rubber from only a few hundred acres. They have therefore been limited to sheet production except where a buyer for liquid latex has been found. With limited capital and production they have benefited only from specialisation of labour, from smoking and from joint marketing. Little advantage has been obtained from the use of better equipment and the profit margin has in many cases been insufficient to hold them together except where the co-operative spirit is strongly established.

Wherever collection of latex from smallholders has been organised the system has become popular with the owners of holdings providing prompt payment is made and the return is at least equivalent to that for unsmoked sheet rubber. Cessation of latex collection in any area where it has once operated generally causes dismay, although in contrast the share tapper objects to smallholders selling latex because the tapper's control of division of the crop is thereby reduced.

Rural and Industrial Development Authority

Large factories capable of producing more than one type of marketable rubber which are required to give smallholders the full benefit of centralisation of processing are beyond the potentialities of co-operative action as it has been observed to date. In large modern factories skilled management and technical control of production are required. These and the necessary capital must be provided initially by some official agency.

The construction of such large factories has been made possible by the inauguration in 1950 of the Rural and Industrial Development Authority. The Authority has been provided with the necessary powers and finance to develop rural industries for the benefit of the primary producer. For rubber production a start has been made with the construction of a large factory serving an area containing about

A well-kept shed for the preparation of rubber on a smallholding

A young replanting on a Chinese holding, showing cultivation of yam beans between the rubber rows

8,000 acres of smallholders' rubber at Grisek in Johore. This factory is just completed and will initially be capable of producing 4,000 lb. to 6,000 lb. of smoked sheet per day. The Grisek scheme is essentially a pilot project and it will provide much useful information to guide the scale of development of future undertakings.

Conclusion

Replanting and centralised processing appear to be two essentials for the future of rubber smallholders. Both require immediate attention and effective action and neither should be allowed to be set aside as less important than the other. The replanting of vast acreages of smallholders' rubber might be a wasted effort if, in the meantime, the product of smallholdings should become discredited in the eyes of rubber users as a result of failure to develop satisfactory methods for standardisation and improvement in competition with synthetic rubber. On the other hand, an elaborate organisation for the transportation and processing of smallholders' latex will be of little value if smallholders' production is to be allowed to decline.

There are also other subjects in which a smallholder requires guidance and assistance of a technical nature.

The greater the progress made in enabling smallholders to improve their economic position the greater will be the need to provide them with information and assistance on matters of technique. Since 1945 the advisory service for rubber growers has been unable to expand to the extent required because of lack of suitably qualified persons willing to take up this type of work. Additional men must be trained and improved efficiency sought from each one of them, but it is important that the best use should be made of existing technical resources by careful integration of all developments affecting rubber smallholders.

Indonesian Rubber Conference

The first conference of the People's Rubber Service took place during February in Bogor. During the five days of the conference a programme was drawn up for the expansion of production by smallholders' rubber enterprises, both plantations and processing plants. In a Press statement prior to the opening of the conference, the director of the Central Bureau of the People's Rubber Service stressed that it was intended to find means to consolidate and increase exports of rubber produced by smallholders, and at the same time to raise the quality and increase the output of smallholders' rubber. It is also announced that Indonesian smallholders will be represented in the Bogor Rubber Research Institute and the Rubberstichting at Delft. The costs of the services provided by these bodies are to be met from the export duties imposed on smallholders' rubber.

Among those who attended were the Minister of Agriculture, Mohammed Sardgan, the Head of the Central Smallholders' Rubber Office, Mr. Suparman and the Head of the Indonesian Committee of the Rubber Study Group, Mr. Sadgarwo. Outlining the policy for 1953, Mr. Suparman mentioned investigation of ownership and production value of smallholders' rubber, organised replanting and the need for quality to do this.

E.C.G.C. Progress Reports Received

Following last month's review (WORLD CROPS, **5**, 4, p. 142) of four Progress Reports from Experiment Stations of the Empire Cotton Growing Corporation, we have now received a further five reports from Northern Nigeria, Kenya, Southern Rhodesia, Queensland and the West Indies, relating to the season 1951-52.

The report from **Northern Nigeria** runs to 25 pages and includes a general introduction by H. D. King in addition to the departmental reports. The 1951-52 cotton crop showed a spectacular increase over the previous record season totalling 113,510 bales compared with 76,390 bales. Some anxiety is being felt over loss of fruit by shedding which is associated with damage of the type caused by *Lygus*. The damage this season has been much more widespread than before.

Investigational work in the Nyanza Province of **Kenya** was started in 1951. So far land clearing and fencing have been carried out at three stations in the area ready for the 1952-53 season. Cotton production rose to 11,719 bales compared with 8,594 bales in 1950-51.

At the Cotton Research Station, Gatoona, **Southern Rhodesia,** some hybridisation work has been carried out with the object of transferring blackarm resistance to quality linted strains. Fertiliser experiments have shown that the fertiliser should be placed in a band 2½ in. to one side and 3 in. below the seed level on cotton grown in the red soil area.

Insecticide experiments carried out in cooperation with Messrs. Pest Control (Africa) Limited indicated that it would be economical to apply DDT plus Pestox 3 to cotton under certain conditions.

The report from **Queensland** states that all irrigated cotton grew well due to well-timed waterings. The rain-grown cotton was planted late but yielded up to 1,000 lb. of seed cotton per acre.

From the **West Indies** it is reported that the bulk of the Sea Island crop was of the MSI variety with an acreage exceeding 10,000. Production increased by 7½% to 1,716,000 lb. clean lint.

In Antigua a land-use experiment has been continued for the second season with cotton as the indicator crop following (1) three crops of sugar cane, (2) elephant grass cut for forage over the same period, (3) continuous cotton and (4) continuous cotton broken by a leguminous cover crop in 1949-50.

The grass rotation gave very poor results compared with the other three between which there were no differences.

(*Left*) **Flowering branch of** *Hevea brasiliensis* **showing terminal female flowers and smaller lateral male flowers**
(*Right*) **Fruit obtained from hand pollination—an exceptionally successful result**

Improvement of Yields in Hevea Brasiliensis

E. D. C. BAPTIST, Ph.D. (London), M.Sc., A.R.C.S., D.I.C.
Head of Botanical Division, Rubber Research Institute of Malaya

The spectacular increases that have been made possible in the yields of rubber by planting trees derived from improved clones, propagated by budding or by the use of legitimate clonal seed, are among the greatest triumphs of the plant breeder and the geneticist. What has been accomplished in this direction and the techniques involved are described below by Dr. Baptist, who is the head of the Botanical Division of the Rubber Research Institute of Malaya.

HEVEA brasiliensis (Muell. Arg.), Natural Order *Euphorbiaceae*, is the only *Hevea* species cultivated under plantation conditions and it accounts for almost the whole of the world natural rubber production of 1,875,000 tons in 1951, of which Malaya contributed 605,346 tons (32%).

Of the 3,555,346 acres of *Hevea brasiliensis* in Malaya at the end of 1951, 1,975,473 acres are on estates and 1,579,873 on smallholdings (areas of less than 100 acres).

The bulk consists of low-yielding unselected seedling trees and only 628,116 acres are planted with approved high-yielding material.

The introduction of *Hevea* to the East

Malaya received its first plants of *Hevea brasiliensis* in 1876 in a consignment from Kew Gardens, representing a very small proportion of the seedlings raised at Kew from the seeds collected in Brazil by H. A. Wickham Esq. (later Sir Henry), who was commissioned to collect rubber seeds by Sir Joseph Hooker, then Director of Royal Botanical Gardens, Kew. Owing to delay in transit these arrived in poor condition and there is no record that any survived.

A second importation consisting of 22 plants in 1877 was, however, completely successful. Thirteen seedlings were established at the Singapore Botanic Gardens and the remaining nine in the Residency Grounds at Kuala Kangsar in Perak.

It seems fairly certain that these plants and others subsequently introduced from Ceylon were grown from the seed collected by Wickham and that the *Hevea* trees grown in the East today are the progeny of the trees raised from the seeds which Wickham collected.

Brazil was the only source of supply of rubber until the progeny of the plants introduced into Asia began to come into bearing in the early years of the present century.

Tapping technique

The first tapping of *Hevea* in the East was done by Trimen in Ceylon (1882), using numerous small incisions.

Ridley's experiments on tapping were carried out at the Singapore Botanic Gardens and his discovery of the effect of taking successive shavings of the bark on a herring-bone pattern at daily intervals led to the rapid expansion of the plantation rubber industry in Malaya, Ceylon, Java and Sumatra, and to the development of the single cut and the present-day standard system of a half-circumference cut tapped on alternate days.

Yield variability

Improvement of *Hevea* planting material is based on the large variability in yield between individual trees in a seedling population. Lock, in Ceylon (1913), drew attention to this and stressed the importance of planting seed from the best yielding trees.

The first systematic study of this vari-

ability was made by G. S. Whitby on a Malayan estate in 1913.

He examined about 1,000 seven-year-old trees and found that 9.6% gave 28% of the total yield.

The yield frequency curve showed a marked skew distribution; the majority of the trees giving less than the mean yield and a small number of the best trees contributing a considerable proportion of the total yield.

This high coefficient of variability for yield (in Whitby's population it was 76%) is, from the view of the plant breeder, a great asset since the presence of trees giving several times the mean yield provides valuable material for selection.

Whitby's findings were confirmed by many other workers, and it was also established that the differences were in the main due to genetic factors.

New R.R.I.600 series clones in a large-scale trial with five replications of each clone

Yield improvement

The second important step was the successful outcome of experiments on bud-grafting of *Hevea* in 1917 by van Helten and Bodde in Java, under the guidance of the late Dr. P. J. S. Cramer, as it provided the means of fixing the characters and of multiplying to an unlimited extent trees possessing desirable characters; trees of the same clone being of the same genotype. The way was now clear to improve yields by the combination of selection and vegetative propagation.

In 1916-17 selection began in Sumatra, where the A.V.R.O.S. Proefstation isolated a series of high-yielding trees, and after a period of tapping selected a number of them and made clones from these. The clones were established in special isolated seed gardens and the seeds obtained as a result of free pollination (' clonal ' seeds) used as planting material.

The earliest work on the inheritance of high-yield characters was carried out by Heusser of the A.V.R.O.S. Proefstation in 1920.

An important principle laid down by Heusser was that the value of a seedling tree could only be determined with certainty from the yields of the buddings made from it.

In Java Van der Hoop (1917-18) selected high-yielding trees and with the clones made from the trees established the well-known Tjikadoe seed gardens of West Java.

The illegitimate seedlings of budded trees established in seed gardens showed a great improvement on the progeny of the best yielding unselected seedling trees. The latter, when they reached the bearing stage, were found to yield only 18% to 38% higher than unselected seedlings, the reason being that the pollen parents in many of the natural crosses were of the type which gave a high proportion of low-yielding seedlings.

The next step, therefore, was to breed from high-yielding clones by artificial pollination and to make new clones from the legitimate seedlings obtained, and in this connection the early flowering of budded trees proved a factor of considerable value to the plant breeder.

Vegetative and generative breeding

The selection of good types, and their propagation by vegetative means was followed by the production of new types by controlled hand pollinations. Success has been achieved by a combination of vegetative and generative methods whereby new characters introduced by controlled pollinations are fixed by bud-grafting. The selection work has been largely carried out by estates, but the breeding work is a long-term undertaking which forms an integral part of the programmes of research organisations that serve the industry.

Three such organisations, apart from this Institute, exist in Malaya, namely, the Prang Besar Rubber Company Ltd., the Socfin Company, and Chemara Plantations Ltd.; these employ scientific staff to carry out breeding work. Two of them have put on the market proprietary clones and seeds from their seed gardens.

Breeding work under the direction of the late Dr. R. J. Chittenden by the Prang Besar Rubber Company began in 1928, although selection had begun earlier. Clone P.B.86 and Prang Besar Isolation Garden seed from gardens C, D and E have been developed by this company.

Detecting good yielders

The desirability of being able to detect good yielders at an early age was realised early, and research workers in Malaya, Java, Sumatra and Ceylon have investigated the possibility of high yields being related to some measurable anatomical character such as girth of main stem, thickness of ' bark ' or number of latex vessel rows in the ' bark.' None of these characters showed, however, a sufficiently high correlation with yield to justify its use for breeding purposes.

The ' Testatex ' method of nursery selection, advocated by Dr. P. J. S. Cramer, which consists in pressing into the main stem of one-year-old seedlings the blades of a specially designed knife and measuring flow of the latex has been critically examined at this Institute and found to be unreliable. An improvement of the Testatex method, the ' Retex Method,' patented in 1952 by Dr. Cramer, has received favourable reports from the Belgian Congo, but has not been yet put to the test in Malaya.

Gunnery's findings at this Institute in 1935 of the relationship between sieve tube diameter and yield are not sufficiently consistent for general application.

The ' ten-day test,' known as the Hamaker - Morris - Mann system, which consists of tapping trees at an early age (3-3½ years old) on a half-spiral cut daily for ten days and recording the yields on the last five days is the only reliable method of yield prediction so far devised, and it is interesting to note that in the original experiment which has been in progress since 1932 the yields of a collection of clonal seedlings in 1951 still show

a significant positive correlation with test-tapping yields recorded in 1932 when the trees were 3¼ years old.

The progress of breeding and selection work at the Rubber Research Institute of Malaya is briefly described below; by the application of well-established methods yields have been increased in 28 years from a level of about 500 lb. of rubber per acre per year to recorded yields of over 2,000 lb. per acre per year from the best of the selected material.

Hand pollination

The flowers of *Hevea* are borne near the terminal end of young twigs. The typical inflorescence is much branched, the female flowers occur at the terminal end of the central axis and the main side branches, while the male flowers occur on the lesser branches.

In preparing an inflorescence for pollination all male flowers and opened female flowers are removed, leaving only the unopened female flowers. The perianth lobes are gently forced apart and the staminal column of a mature male flower of the selected male parent is inserted over the stigma, kept in position with a plug of cotton-wool and sealed with a drop of latex. After about five months, if the operation is successful, the fruit, which is usually enclosed in a mesh bag to retain the seeds after the dehiscence of the valves of the capsule, is ready for harvesting.

The success of hand pollination varies from 2% to 8%, with an average of about 4%, and depends on the degree of fertility of the clones. Some clones are self-sterile, while others are to a large extent self-fertile.

Other factors affecting the success of hand pollination are the skill of the operator and the weather at the time of flowering, which in Malaya normally extends from February to June.

Seedling propagation

The legitimate seed is germinated in a rat-proof enclosure and the seedlings are kept in the nursery until they show 4-5 ft. of brown bark on the main stem. When this stage is reached each seedling is cut back at 2-3 ft. from the ground and the top used as budwood to produce a clone. Each new clone is tested in a small-scale trial against a proved clone as control.

Clones from the small-scale trials are selected for yield and secondary characters, and also for the character of their latices, and further tested in large-scale experiments on different soil types for at least five years.

The final recommendation of a clone for use on a commercial scale is usually made some 18-20 years after the date of the original hand pollination which produced the bud mother tree.

The practical application of bud-grafting to estates practice in Malaya was largely due to C. E. T. Mann, at present Director of this Institute.

Small-scale trial of new R.R.I. clones. These trees are 13½ years old

Breeding programme of the R.R.I.

The programme of research of the Rubber Research Institute of Malaya for 1927 provided for a comprehensive investigation of the general problem of improvement in yield of *Hevea*. Buddings established on Pilmoor Estate in 1924 and some other clones made from estate mother trees were used by Morris in seven series of crosses carried out from 1928 to 1931.

Breeding work was suspended in 1932 owing to retrenchment of staff as a result of the industrial depression, but the legitimate seedlings developed by Morris and planted on the R.R.I. Experiment Station during the years 1929 to 1932 were kept under observation and brought into tapping in 1935 and 1936. Illegitimate seedlings of the parent clones, *i.e.* seedlings of which only the female parent is known, and ordinary unselected seedlings were planted in same plots for purposes of comparison.

Wide differences in yield were found among the individual members of each family, but the coefficient of variability, though high (about 50%), was lower than that of illegitimate clonal and unselected seedlings.

The main results obtained from this breeding programme may be summarised as follows:

Clones made from selected mother trees yielded much more than the average of the population.

Families of seedlings obtained by breeding between these clones gave mean yields greater than those of their parents.

The illegitimate seedlings of the best parent clones may give yields which are not appreciably inferior to those of their parents.

A proportion of new clones made from outstanding trees of the legitimate seedling families gave double the yield of the original clones from which they were derived.

Breeding results and recommended clones

Of the 989 new clones made from seedling crosses and tested in small-scale trials 30 were selected for further testing in large-scale trials and given numbers in the R.R.I.500 series.

Four of these are now recommended for use on estates: clones R.R.I.501 and 513 on a large-scale and clones R.R.I.526 and 527 on a limited scale.

The second stage of the breeding work at the R.R.I. commenced in 1937, using the most promising clones developed in Malaya, Java and Sumatra, and was continued up to the end of 1941 when it was interrupted by the Japanese invasion.

In the first series of crosses clones Tjirandji 1, Avros 157 and Pilmoor B.84 were crossed with each other and with seven other clones; in later crossings selected clones of the R.R.I.500 series were crossed with each other and with a number of the older proved clones.

Of the older proved clones the outstanding parents are Tjirandji (Tj.) 1, Avros 157, P.B.49 and of the newer R.R.I. clones R.R.I.501 and 509 are the most promising and can be recommended for use in seed gardens provided they are not included with other clones which have clone Pilmoor A.44 as one parent.

Clones P.B.24, Av.33 and R.R.I.500 cannot be recommended, for their seedlings although vigorous and high yielding, are highly susceptible to 'brown bast,' a physiological disturbance as yet imperfectly understood.

Clones Pil.B.84 and Lunderston N have produced good families in certain crosses but they are shy seed bearers and are not generally recommended.

The high-yielding clones, P.B.86 and Glenshiel 1, have produced seedling families below average in yield, whilst some of the best in these series of crosses have as one parent clone Avros 157 or

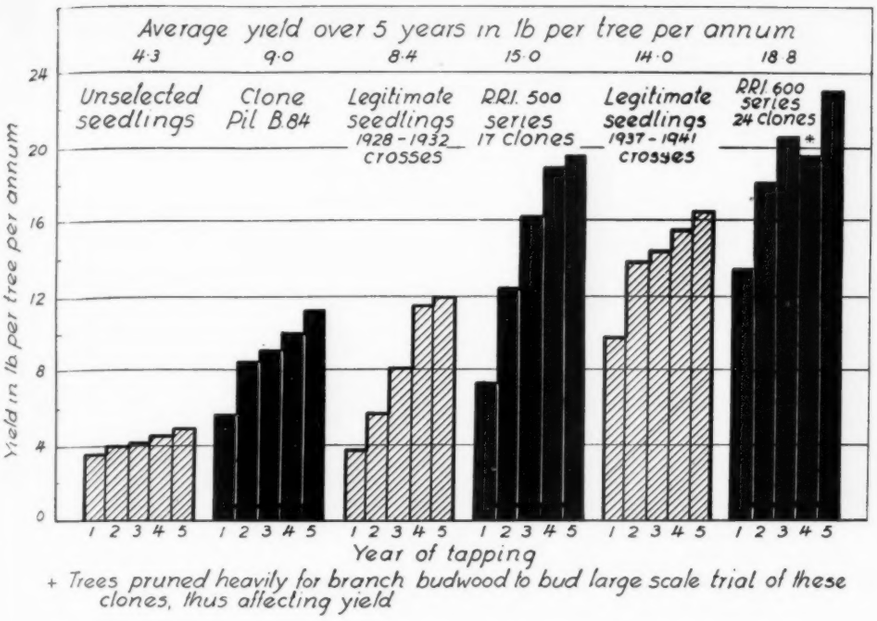

Average yield over 5 years in lb per tree per annum
4·3
9·0
8·4
15·0
14·0
18·8
Unselected seedlings
Clone Pil B.84
Legitimate seedlings 1928 - 1932 crosses
RRI. 500 series 17 clones
Legitimate seedlings 1937 - 1941 crosses
RRI 600 series 24 clones
Yield in lb per tree per annum
Year of tapping
+ Trees pruned heavily for branch budwood to bud large scale trial of these clones, thus affecting yield

Fig. 1, showing progress of selection, breeding and further breeding

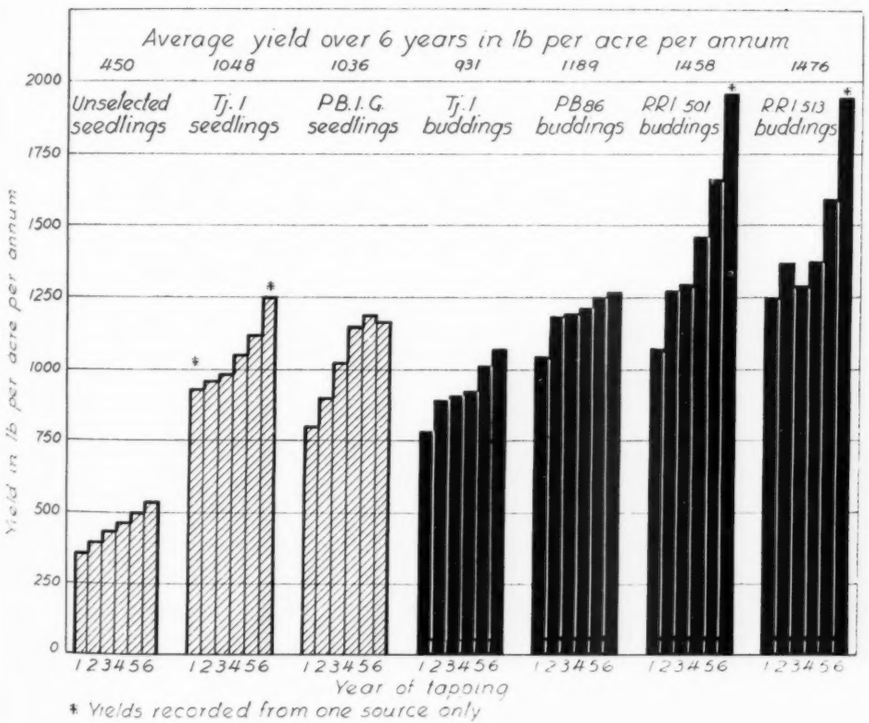


Fig. 2, showing improvement of *Hevea* planting material

P.B.49 which have long been discarded as second-class clones.

Disappointing results have been obtained in three series of crosses with the seedlings of Tj.1 x Pil.B.84, although both parents produce high-yielding seedlings when crossed with many other clones.

The depressing effect of inbreeding on vigour has been clearly demonstrated.

Trees with yellow foliage have been found to occur in 30% of a population of seedlings of the cross of P.B.86 x Pil.B.84 and of P.B.24 x Pil.B.84; the yellow seedlings were inferior in vigour and yield. Yellow seedlings did not occur in the crosses of these two P.B. clones with Avros 157 or Tj.1, or in any of the crosses of Pil.B.84 with the other clones.

Clonal selection from 1937-41 programme

Of the 2,186 new clones made from the legitimate seedlings of the 1937-41 programme, 31 have been selected (R.R.I.600 series) and have been budded in 39 field trials on estates. A further 184 clones remain in small-scale trials and will provide material for further selection.

Clones of the R.R.I.600 series have better secondary characters than those of the 500 series. Their superiority as yielders is well brought out in Fig. 1.

The histogram shows that the R.R.I.600 series clones are capable of yielding more than four times as much as the ordinary unselected trees from which they have originated by selection, breeding and further selection.

Breeding and selection since 1947

The third stage of the breeding and selection work of the R.R.I. of Malaya commenced in 1947, and in this programme R.R.I.600 series clones have been used in a series of wide crosses and back crosses.

Since 1947 1,434 legitimate seedlings of crosses have been made and established in field trials and 1,274 new clones made from a selection of them have been budded in small-scale trials.

The histogram in Fig. 2 has been prepared from yield data recorded in commercial and experimental plantings.

These records have been obtained from commercial plantings of different ages.

The conclusion may be drawn that, at least for the first six years of tapping, clone P.B.86 gives slightly better returns than the seedling families (P.B.I.G. seed from gardens C, D and E and Tj.1 selfed seed), which in turn yield more than buddings of clone Tj.1, while the R.R.I. clones 501 and 513 give the highest yields of all.

The older proved clones and seedling families have given twice the yield, the newer R.R.I. clones three times the yield of the unselected seedlings, while reference to Fig. 1 will show that the R.R.I. clones of the 600 series may give a fourfold increase of the average yield of unselected seedling trees.

Future breeding work

What of the future? We seem to be approaching the ceiling of yield improvement of the 'Wickham' material introduced into the East in 1876 and 1877, and although there is room for more improvement the slope of the curve of increase in production is gradually becoming less steep.

New 'blood,' *i.e.* new introductions

from tropical America, with appropriate quarantine safeguards, of material with a wider range of variability might be expected to lead to further improvement in the yield of *Hevea brasiliensis* in the Eastern Hemisphere.

In future breeding programmes especial attention will be paid to resistance to *Dothidella ulei*, the fungus responsible for South American leaf blight, one of the most destructive diseases of cultivated plants; the risk of its introduction to the East must be kept constantly in view.

The R.R.I. of Malaya has negotiated an exchange with the Instituto Agronomico do Norte, Belem, Para, Brazil, whereby budwood of 25 selected R.R.I. clones of the R.R.I.500 and 600 series has been despatched early in 1952 to Brazil, and in return budwood of the same number of selected blight-resistant clones has been despatched from Brazil to Coconut Grove, Miami, Florida, a quarantine station of the U.S.D.A. outside the American tropics, where the clones are being multiplied and kept under observation until the budwood is despatched to Malaya in 1953 through the Commonwealth Mycological Institute, Kew, England.

Hand pollination. The staminal column of the male flower is being inserted within the perianth of the female flower

One of the aims of the breeding work of the Rubber Research Institute of Malaya will henceforward be to develop clones combining high yield with resistance to South American leaf blight, the latter to be tested later at a convenient station within the known range of *Dothidella ulei* in the Western Hemisphere.

FAO Request for Forage Seeds

The Working Party of FAO on Mediterranean pasture and fodder development is looking for sources of seeds of certain species of grasses, legumes and other forage plants for sowing in the Mediterranean areas of low rainfall with long periods of summer drought. It is hoped, as far as possible, to obtain seed of drought-resistant strains of these species produced in areas with this type of climate.

FAO will welcome quotations from suppliers of any of the seed species listed below, referring to seeds from the 1952 or 1953 crop and specifying strain, origin, grade, purity and germination of each strain.

LIST OF SPECIES, SEED OF WHICH IS REQUIRED FOR SOWING IN 1953

(Except where indicated otherwise, approximately 1 lb. is required)

GRAMINAE

1. *Agropyron amurense*
2. *Agropyron cristatum*—Fairway (20 lb.)
3. *Agropyron cristatum*—Rhizomatous (20 lb.)
4. *Agropyron intermedium* (P. 2327)
5. *Agropyron smithii*
6. *Agropyron trichophorum*
7. *Andropogon hirtus*
8. *Andropogon ischaemum*
9. *Anthoxanthum odoratum*
10. *Bromus catharticus* (syn. unioloides)
11. *Bromus inermis*
12. *Chloris gayana*
13. *Cynodon dactylon*
14. *Cynosurus cristatus*
15. *Dactylis glomerata* (Hispanica) (20 lb.)
16. *Eragrostis chloromelas* (20 lb.)
17. *Eragrostis curvula* (20 lb.)
18. *Eragrostis lehmanniana*
19. *Ehrharta calycina* (20 lb.)
20. *Ehrharta longiflora*
21. *Festuca arundinacea*—Gaur (20 lb.)
22. *Festuca arundinacea*—Kentucky 31 (20 lb.)
23. *Festuca arundinacea*—Alta (20 lb.)
24. *Festuca elatior*
25. *Heteropogon contortus*
26. *Hilaria belangeri*
27. *Hilaria jamesii*
28. *Hordeum bulbosum* (800 lb.)
29. *Lolium multiflorum*
30. *Lolium perenne*
31. *Lolium rigidum* (20 lb.)
32. *Lolium strictum*
33. *Œnotheria odorata*
34. *Oryzopsis holciformis*
35. *Oryzopsis miliacea* (800 lb.)
36. *Panicum antidotale*
37. *Panicum bulbosum*
38. *Panicum miliaceum*
39. *Panicum muticum*
40. *Panicum prolutum*
41. *Paspalum dilatatum*
42. *Pennisetum clandestinum*
43. *Pennisetum purpureum*
44. *Pennisetum villosum*
45. *Phalaris tuberosa* (800 lb.)
46. *Phalaris tuberosa stenoptera*
47. *Phleum pratense*
48. *Phleum pratense* (diploid)
49. *Poa ampla*—Sherman
50. *Poa bulbosa*
51. *Sorghum vulgare*
52. *Sorghum vulgare sudanense*
53. *Stipa cernua*
54. *Stipa pulchra*

LEGUMINOSAE

55. *Astragalus cicer*
56. *Hedysarum coronarium* (20 lb.)
57. *Lathyrus articulatus*
58. *Lathyrus tingitanus*
59. *Lespedeza sericea*
60. *Lotus corniculatus*
61. *Lotus criticus*
62. *Lupinus angustifolius*
63. *Lupinus luteus*
64. *Medicago arborea*
65. *Medicago hispida* (20 lb.)
66. *Medicago sativa*—Hairy Peruvian (400 lb.)
67. *Medicago sativa*—Ladak (20 lb.)
68. *Medicago sativa*—Nomad (20 lb.)
69. *Medicago sativa*—Ranger (20 lb.)
70. *Medicago sativa*—Rhizoma (20 lb.)
71. *Medicago sativa*—Sevelra (20 lb.)
72. *Medicago tribuloides* (400 lb.)
73. *Melilotus indica* (30 lb.)
74. *Melilotus officinalis* (30 lb.)
75. *Melilotus scutallata*
76. *Onobrychis viciaefolia*
77. *Ornithopus sativus*
78. *Psoralea bituminosa*
79. *Pueraria thumbergiana*
80. *Trifolium alexandrinum*
81. *Trifolium fragiferum*
82. *Trifolium hirtum*
83. *Trifolium incarnatum*—Dixie
84. *Trifolium incarnatum*—Auburn
85. *Trifolium incarnatum*—Autauga
86. *Trifolium pratense*—Espanol
87. *Trifolium pratense*—S. 151
88. *Trifolium repens purpureum*—Ladino
89. *Trifolium resupinatum*
90. *Trifolium subterraneum*—Bacchus Marsh (20 lb.)
91. *Trifolium subterraneum*—Clare (20 lb.)
92. *Trifolium subterraneum*—Dwalganup (20 lb.)
93. *Trifolium subterraneum*—Mangeela (20 lb.)
94. *Trifolium subterraneum*—Mount Barker (20 lb.)
95. *Trifolium subterraneum*—Tallarook (20 lb.)
96. *Vicia sativa*
97. *Vicia monantha*

MISCELLANEOUS

98. *Artemisia campestris*
99. *Artemisia herba alba*
100. *Atriplex numularia*
101. *Atriplex semibaccata*
102. *Kochia indica*
103. *Sanguisorba minor*

The Potentialities of Rubber as a Raw Material for Agricultural Machinery Construction

PART I

J. M. BESKINE, B.Sc.(Eng.), A.M.I.B.A.E.

By taking rubber for granted we are liable to overlook its full range of possibilities. Although good use is being made of rubber and rubber-like parts and components in agricultural machinery and equipment construction, a fuller appreciation of what rubber can do and of how to design in rubber, would probably further simplify and improve many types of machines and implements.

THESE are the conclusions which force themselves upon any student of agricultural machine design as soon as he commences to become interested in rubber. And it is the purpose of this article to attempt to survey the existing applications of rubber in agriculture and to indicate design and utilisation trends which appear to be worth greater consideration by all who are interested in the production and exploitation of machinery and other equipment in crop and animal husbandry.

What should be known about rubber?

Natural rubber is mainly derived from rubber tree plantations in the tropics. In some countries, including the U.S.A. and the U.S.S.R., rubber is also derived, although on a restricted scale, from other plants, *e.g.* guayule and kok-saghyz, etc. But however it is obtained, natural rubber is the basis of a large range of different materials. Or, more correctly, it is possible to manufacture from natural rubber various kinds of industrial rubber such as soft vulcanised rubber, hard vulcanised rubber, latex foam, etc.; while the rubber product can be fabricated in a large number of ways, reinforced with various materials, impregnated into leather and bonded to metal. In each instance, by varying the composition of the compounding ingredients—of which there are several hundred—and by suitable processing, it is possible to alter considerably the physical and chemical properties of the final product within a large field of possibilities.

Rubber crawler track on a Massey-Harris combine harvester designed for soft ground conditions

Two facts must be appreciated when comparing rubber with other materials. Firstly, although data are available for various rubber products and compounds, in practice it is essential to carry out performance tests under working conditions in order to ascertain just what a particular type of rubber product and component will be able to do when in service.

The second fact is that it is possible to manufacture industrial rubbers and rubber products which have, for example, maximum abrasion resistance, or maximum tensile strength, or maximum oil resistance, or maximum cold resistance or heat resistance, etc.; but it is not possible to produce a universal maximum duty industrial rubber which is capable of withstanding equally every kind of arduous duty.

It is not possible to produce all of these maxima simultaneously with maximum resistance to ageing and fatigue. One must choose those properties which are to be emphasised by formulation and processing during manufacture; other properties, although desirable, may have to be to some extent sacrificed.

Interdependence of physical properties

The reason for this is that the physical properties of natural—and artificial—rubber are largely interdependent.

Although an infinite combination of properties is possible, unreasonable demands should not be made. For example, it would be foolish to insist on a high tensile rubber for a cushioning member which is never subjected to tension. When selecting a material for a given purpose a compromise is generally necessary as the optimum value of all the physical properties cannot be attained at the same time. Some properties are directly compatible, but others are definitely incompatible. Then again, some properties are

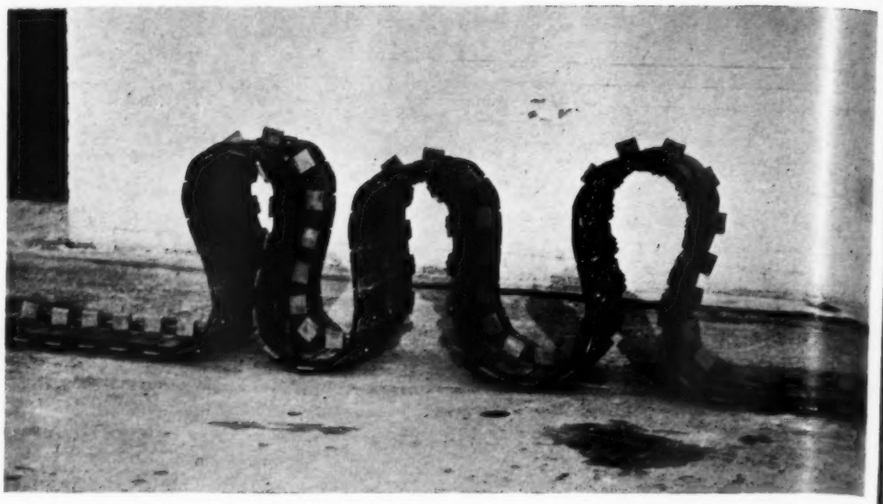
' related ' in a haphazard and unpredictable manner. For example, improving the abrasion resistance of a rubber by formulation and processing usually results in an automatic and simultaneous improvement of hardness: these properties are compatible. But increasing the hardness of a rubber leads to a decrease in resilience, for these two properties are incompatible. Abrasion resistance and tensile strength are examples of properties which cannot be related; almost any kind of combination of these two properties is possible. Purchasers of industrial rubber components may now appreciate some of the reasons for disappointing results in the past.

The use of lightly vulcanised crepe

Natural rubber prior to processing, *i.e.* in its crude state, will freeze or harden at 45° F. and become tacky at about 120° F.; it will absorb water and will dissolve in petrol. It contains about 3% resin and may contain dirt. As shipped from the plantations ready for processing and vulcanisation, it is generally in one of three principal forms, smoked sheet, crepe or liquid latex.

Smoked sheet is never used without further processing; it is normally vulcanised during fabrication, typical examples being tractor tyres, rubber hose and driving belts. Crepe is employed without further processing for the manufacture of footwear soles and bandages; this is because of its good abrasion resistance and adhesive properties. The main drawbacks to the further application of unprocessed crepe are its low temperature range and its inability to withstand solvents such as oil, grease and petrol.

For industrial purposes it is possible to make use of a lightly vulcanised crepe rubber. An example is Linatex crepe which contains 95% crepe rubber. This has a vastly increased abrasion resistance and, what is more important still, an improved working temperature range. Crepe normally becomes tacky as 180° F. is approached and becomes ' frozen ' at 45° F., but light vulcanisation overcomes these limitations. Material of this kind has numerous applications. It is valuable where shock and abrasion must be resisted and is a good chute lining when handling abrasive materials. Crepe, lightly vulcanised or not, according to the requirements of the job, could be of increased value to agriculture, provided the price is right. But, apart from price considerations, more use might be made of crepe and, for that matter, smoked sheet, which has a greater tensile strength, tear resistance and abrasion resistance than untreated crepe.



A steel-and-rubber crawler track; new sections can be added without difficulty or loss of time

Manufacturers of agricultural equipment could probably benefit equally with their customers from the use of such materials for abrasion resisting parts. They would have to be so arranged as to be easily replaceable and, standard sheets, cut up to size, should be employed.

Utilising latex

Liquid latex as it comes from the tree contains about 30% by weight of rubber. By getting rid of the water the resulting rubber has improved properties as compared with crepe and smoked sheet. Latex is now being shipped overseas in concentrated form, containing about 60% rubber, from the rubber-producing countries to the rubber manufacturing centres in Britain and elsewhere. Liquid latex can be regarded almost as an engineer regards molten metal; it can be sprayed on to metals and fabrics; articles can be dipped into latex; it can be centrifuged within moulds to produce hollow articles; and it is possible to produce complex sections and composite partly hard and partly porous rubber articles with the aid of latex. Another important consideration is the production of high duty industrial rubbers from latex rather than crepe or smoked sheet.

Importance of vulcanisation

Prior to vulcanisation rubber has a low strength and a low recovery following distortion under load and removal of the load. It is highly plastic and very soluble in solvents, such as petrol and oil; the freezing point is high and the softening point is low. After vulcanisation, the strength is improved, the recovery after loading is more satisfactory, the plasticity is lowered, the solubility in solvents reduced, the freezing point lowered and the softening point raised. Vulcanised rubber recovers almost completely after extreme distortion by tension, compression, torsion or shear. Other materials may be more elastic or more resilient, but their range of elasticity is generally limited to small deformations, 10% or less, whereas natural rubber-based materials can be stretched 600% of their original length and yet recover within a few per cent.

Although less strong than steel, the ability of rubber to recover its original shape after extremely high deformations permits it to store much more energy than any other material. The energy-absorbing abilities of a typical rubber and of other engineering materials proves this point. The following figures are in ft./lb. of energy stored during distortion under load, per lb. of material: grey cast iron, 0.37; extra soft steel, 3.07; phosphor bronze, 4.08; rolled aluminium, 7.56; hardened and tempered spring steel, 95.30; hickory wood, 122.5; vulcanised rubber, 14,600.0.

Manufactured rubber

Whatever the type of raw material employed, latex, crepe or smoked sheet, a greater or lesser degree of processing and fabrication is required before one of the well-known varieties of industrial rubber is produced. Five kinds of ingredients are or may be added: vulcanising agents, plasticisers, protective agents, reinforcing agents and filling agents. Vulcanisation is generally carried out in a heated mould or an autoclave and during this operation the rubber enters into chemical combination with the sulphur and agents designed to accelerate the vulcanising action. The vulcanising operation sets the rubber into the final shape required which may be a

special moulding designed to suit a machine builder, or a built-up article such as a tyre or crawler tractor track part, or a length of extruded hose or armoured hose, etc.

The other ingredients are added for reasons such as these:—

(*a*) To resist sunlight and to improve the length of life of rubber.

(*b*) To vary the mechanical properties of the rubber, *e.g.* to increase by compounding, the tensile strength from, say, 2,000 lb. per sq. in. to 4,500 lb. per sq. in. and simultaneously to reduce the elongation.

(*c*) To reduce the price of materials which do not have to withstand extreme conditions, or for which length of life is not so important as price, especially when rapid changes in the price of raw rubber may cause marketing difficulties.

Built-up products, made of rubber, plus fabric, etc., are vulcanised after completion. The example of tyres is well known; another and more recent example is the rubberised steel-reinforced crawler track for tractors.

Some firms are now manufacturing crawler tractors equipped with rubberised tracks. In such designs a steel cable or linkage construction is first manufactured and this is the skeleton of each track element. It possesses great tensile strength, flexibility due to the swivel or hinge incorporated in the design of the linkage, and the ability to be fastened to other track elements at either end. Each track element is covered with rubber and vulcanised. A tough wear-resisting rubber is, of course, employed and each link is fastened to the next one by external fittings. The point is that the flexing portion of the track element is permanently covered by rubber. This development, simple as it may appear to be, was long rendered possible by advances in rubber-processing technique, but it is only within recent years that a satisfactory steel skeleton structure was developed. It is also important to note that rubber in all states can be machined. Most rubber compounds can also be machined and given a good finish if required. The bonding of rubber on to metal is a very important field of application too, but this will be discussed subsequently.

Fordson tractor with Cuthbertson steel wire reinforced rubberised half-track

This newly developed tea-plucking machine employs rotating blades edged with rubber. Power is supplied by a portable generator or fractional h.p. motor

Properties of manufactured rubber

Manufactured rubber can be made with a wide range of mechanical, chemical, electrical and thermal properties. The effect of reinforcing fabrics and structures will be discussed separately. Manufactured rubber may be employed as an insulator; but it can also be made to conduct electricity and in fact, to act as a low temperature heating element.

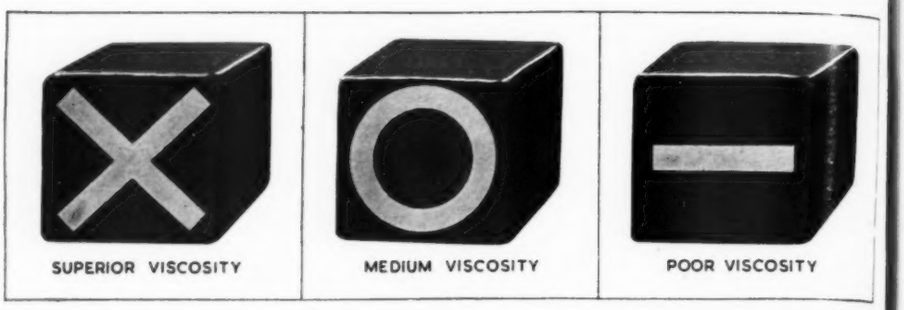
Abrasion resistance is, of course, one of the major advantages of rubber as an agricultural engineering material. Two conditions which must be guarded against where abrasion is a major problem are ageing and excessive extensions; both of these tend to reduce abrasion resistance considerably. An interesting fact is that, within limits, compression appears to increase abrasion resistance. This can be taken advantage of in design. For example, tyres have been made in which compression during blowing up increases wear and abrasion resistance. There is room for skilled application of this principle in many branches of agricultural engineering.

Engineers, including agricultural engineers, are, of course, familiar with the theory of elasticity and its applications to common engineering materials as the theory of structures and the theory of strength of materials. When studying or working with rubber, however, it is necessary to make a new start; the usual terms employed when dealing with the behaviour of metal or wooden parts under stress do not apply when dealing with the elastic behaviour of rubber. Similar terms are employed, but they do not have precisely the same meanings and may be misleading at first. The reason is that rubber does not satisfy Hooks Law (proportionality of

stress and strain) and the same terms are therefore bound to have somewhat different meanings. Nevertheless, it is possible to make rough comparisons between the behaviour of rubber and other materials if due regard is paid to this fact and to the other points mentioned in this article.

The main difference between rubber and other engineering materials is that much greater elastic strains can be imposed on rubber without rupture. The tensile strength of rubber is almost one-third that of steel, calculated on the actual cross-section of the specimen, but its elongation is 6,000 times as much.

Difficulties face engineering designers because the normal methods of engineering calculation do not apply, and the material properties upon which normal engineering design are based cannot be measured easily or directly when rubber, or other similar material, is heavily strained. The average engineer cannot forecast the mechanical behaviour of a rubber product even if he has available data regarding stiffness and viscosity.



The new technical system of grading rubber has been introduced both in Indo-China and Malaya, based on viscosity and vulcanisation properties. Vulcanisation grades are shown by the colour of the symbol (X, O or —); blue, yellow or red for rapid, medium or slow vulcanisation respectively

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The second and concluding part of this paper will appear next month.

The Mokwa Scheme

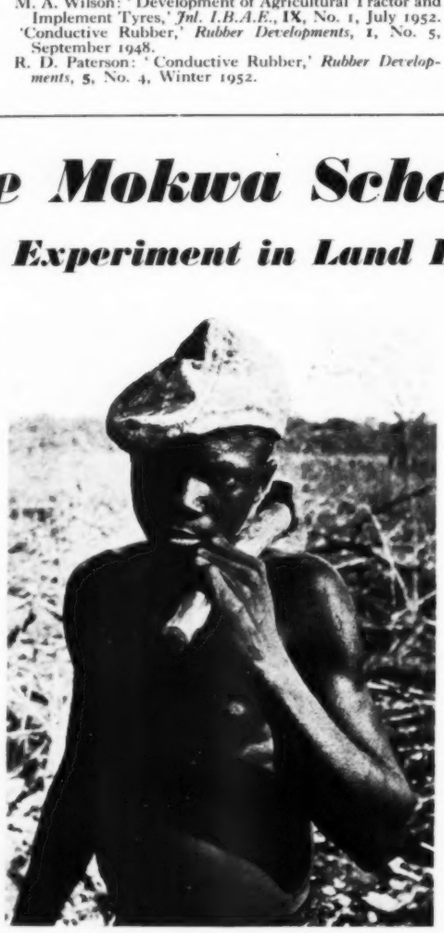
A Nigerian Experiment in Land Development

NIGERIA, with an area some four times that of Great Britain, is one of the most heavily populated parts of the Colonial Empire. Recent estimates have placed its population at some 25,000,000. Yet there are large areas only sparsely inhabited and still awaiting development. It is in one of these regions that the Mokwa scheme is situated.

The West African Oilseeds Mission's report in 1947 contained recommendations for the agricultural development of some 1,300 square miles of undeveloped land in Niger Province, Northern Nigeria. The rainfall here is adequate; more than 35 in. per year. The soils are also good, though rather on the light side. Reasons for retarded development must therefore lie elsewhere; prevalence of tsetse fly may well have been the main factor, though epidemics and inter-tribal wars have contributed.

Pilot plan

In April 1948 the Nigerian Government asked CDC to cooperate in the development of a pilot scheme near Mokwa in the Emirates of Bida and Kontagora. The initial proposals ran through numerous editions, but the final one, based on recommendations made in the Baker-Weatherhead report of 1948, was adopted as a working basis. This report resulted from a visit to the Sudan to study the working of the Gezira Irrigation Scheme—probably the most successful profit-sharing partnership in the world. The first two managers to be appointed to the Niger Agricultural Project, Messrs. H. A. Graves and E. R. John, both had practical experience of the working of the Gezira and kindred schemes in the Sudan and so helped to steer the Mokwa project through its early stages.



A young member of a tree-cutting gang of the C.D.C., Nigerian agriculture project

Responsibilities of partners

Work commenced at Mokwa in April 1949, but the company (Niger Agricultural Project Ltd.) was not finally incorporated till March 1, 1950, and the first meeting of the Board was held a week later. The capital involved is £450,000 in shares of £1, equally held by the Nigerian Government and CDC. There are six members of the NAP Board, also divided equally, but the chairman is appointed by CDC.

Sacks of groundnuts ready for rail transport to Mokwa

Ordinary meetings are held quarterly at Lagos and Mokwa alternately.

The three partners involved in the scheme are the Government, the Managing Company and the Settler-cultivators. Each of these partners has various duties and obligations to perform. These are:

Government will lease land needed; encourage settlement of tenants and provide villages for same; provide for main roads, survey work, tsetse clearance, water supplies, liaison work and advisory committee.

The Company will develop and administer the settlement area; provide minor roads, fertilisers, tractors and agricultural implements needed for cultivation; provide technical and mechanical staff to assist settlers and to train tractor drivers, agricultural overseers, etc.; harvest and take over crops, making cultivation advances to settlers if required; pay settlers their share of the crops grown.

The Settlers will provide labour for scheme and carry out instructions given by Company; will cultivate according to laws of good husbandry and local land tenure; unsatisfactory tenants (after due warning) may be evicted by the Native Authority.

The settlers' share of the crop is one-third, the remaining two-thirds going to the Company.

The land required for the pilot scheme belongs to the Native Authority and has been set aside for 33 years in the first instance. The Company is granted a right of user, free of charge, for this period. The land itself has not been alienated but will be occupied by the settlers under customary local land tenure terms, modified as needed by Regulations under the Land and Native Rights Ordinances.

Progress

The original plan was to settle 10 villages, each of about 80 farmers and their families, in the course of seven years. The individual holding was 36 acres, four years' cropping being followed by two years of resting fallow. Sowing takes place from May to August, with the start of the rainy season, and harvesting of crops commences from October onwards. There is a marked dry season of six to seven months following the rains.

These proposals have since been modified to allow proper rotation of food and cash crops with adequate proportion of fallow land.

The demonstration farm has been greatly reduced in area and will be mainly used to test out crops and rotations.

From the very start clearance has mainly been done by hand; gangs of local workers, supervised by African foremen, undertaking piecework tasks at contract rates. By July 1950 over 4,400 acres had been cleared; a year later this total had been increased to some 6,800. Clearance is now being confined to those areas for immediate cropping and this work is undertaken during the period following the rainy season. After clearance the land is broken up with disc ploughs, drawn by ' Fordson ' half-track tractors. This again is done when the ground is still moist and the land is finally ridged for sowing. Actual sowing has been done mainly by hand, but a prototype planter is being tried out this year. Over 2,200 acres were sown in 1950 and just under 2,000 in 1951; for 1952 the proposed cropping amounted to some 3,900 acres.

The first village (Ndayako) was settled in 1951 and the second (Pamnini) came into operation last year. It is hoped also to sow a token area of No. 5 settlement —as yet unnamed.

A wide variety of crops has been grown: the main ones are groundnuts for cash and Guinea corn (sorghum) for food. In addition, soya, cotton, Bambarra groundnuts (*Voandzeia subterranea*), beans and sunflower have been tried. Plots of kenaf (*Hibiscus cannabinus*) have been grown both years to provide materials for trials carried out by the Colonial Office team investigating the mechanised production of jute and jute substitutes.

Steam ploughing sets, capable of ridging 50 acres daily, have been tried out. These burn wood from cleared land, and so could effect large economies in fuel. Unfortunately, they can only operate efficiently in areas that have been completely destumped.

There have been setbacks. Concealed stumps have wrecked implements; termite hills up to 20 ft. high are common; tall grass has clogged ploughs; roots left in the ground have led to regenerated growth in cleared land. Stainer bugs also damaged the 1950 Guinea corn crop. Many further trials will yet have to be carried out with crops, tractors, implements and rotations before the best and cheapest methods to solve a variety of problems are finally decided.

The future

Even the settlement of villages will take tact and patience, for the farmers are being asked to employ new methods and conform to a time-table for cropping, hoeing and harvesting. Confidence will have to be established that the new ways are better than the old easy-going ones, and that the energetic settler can obtain a good return for his labour.

Water supplies will need further improvement, medical facilities and amenities will require to be incorporated, and a community spirit, rather than an individual one, must be established.

The clearance of bush will eventually lead to the introduction of livestock, without which no system of farming can be termed really balanced.

All this will take time, but results obtained encourage the belief that NAP may form a pattern for the future settlement of some 1,300 square miles potentially cultivable. At present this land is sparsely populated and mainly bush, but it can and should accommodate a settled and prosperous peasant community.

(From *Colonial Development.*)

Systemic Fungicides

P. W. BRIAN, Sc.D.
Imperial Chemical Industries Ltd.

Systemic insecticides are now almost a household world in agriculture, so widespread has their use become and so striking the success which they have obtained. Recently attention has been turned to the possibility of finding fungicides which operate in a similar fashion and the position in this regard is discussed below.

AT present fungicides are used in plant disease control in three ways. These are :—

(1) Fungicides applied to plant surfaces as protectants ; examples of this type of use are control of potato-blight by copper foliage sprays, or seed-dressings applied to prevent soil-borne seedling diseases.

(2) Fungicides applied to plant surfaces to eradicate existing active or latent infections ; examples of this type of use are seed dressings for control of seed-borne disease or application of eradicant foliage sprays in the control of such diseases as leaf-mould of tomato (*Cladosporium fulvum*).

(3) Fungicides applied to loci of infection in the vicinity of some crop which it is desired to protect, as in orchard-floor spraying with dinitro-*o*-cresol to prevent ascospore infection of apples by scab (*Venturia inaequalis*) or the use of formaldehyde as a soil steriliser in glasshouses.

All these are *external* methods of application to the plant. From time to time, especially during the last ten years, plant pathologists have considered the possibility of distributing fungicides *within the tissues* of plants as a means of disease control. The recent discovery of systemic action by a number of insecticides, notably by the organophosphorus insecticides, has increased interest in the systemic application of fungicides. Research is proceeding actively at several laboratories. Several different methods of approach have given clear evidence that systemic control of plant diseases can be achieved. As yet nothing like a practical evaluation of such methods has been reported. We are at the very beginning of new developments and it is not possible at present to do more than speculate on their practical significance.

Recent research

It is not possible here to give a complete survey of published work ; instead, a few researches which may be regarded as landmarks have been picked out for special attention.

The modern period of research on systemic fungicides may conveniently be considered to start with the publication by Müller (1926) of his book *Die innere Therapie der Pflanzen*. In this he exhaustively surveyed all previous work on control of fungus and insect parasites of plants by systemic treatment and described his own researches. His own work was mainly concerned with *Aphis* and but little with fungal diseases, but he made certain observations of general importance. He showed that a wide variety of substances, organic and inorganic, potential fungicides and insecticides, were taken up by plants through cut stems or intact roots. He further showed that nearly all the substances he tried were toxic to plants and that any prospect of the use of systemic methods of application depended upon the existence of an appreciable difference between the dose needed to inhibit the pathogen and the highest dose tolerated by the host plant. None of the substances he tested satisfied that requirement.

Gassner and Hassebrauk (1936) carried out an empirical investigation of a large number of compounds as systemic fungicides ; these were applied to the roots of wheat and barley plants growing in sand culture and the leaves were then infected with a foliage rust, *Puccinia triticina* on the wheat and *Puccinia simplex* on the barley. They obtained very definite signs of disease control with a few substances, notably with chloramine-T and picric acid. Both these substances were phytotoxic and no disease control could be obtained with doses harmless to the host plants. The general result of their researches was to cast doubt on the possibility of finding a systemic fungicide safe in use.

Some years later, however, Roach (1939), in the course of his work at East Malling Research Station on tree injection in relation to inorganic nutrition of plants, found that injection of apple branches with sodium thiosulphate conferred on the foliage a considerable degree of resistance to mildew (*Podosphaera leucotricha*). This interesting observation was not followed up.

The next significant development was based on a different method of approach. This was in connection with a vascular disease, the bleeding canker of maple caused by *Phytophthora cactorum*. This disease, like many vascular diseases of plants, is a toxigenic disease ; that is, many of the symptoms of the disease are produced by a toxin liberated by the parasite within the host plant. The toxin is translocated within the host producing lesions at a considerable distance from the actual infected tissue. Howard (1941) conceived the idea of introducing substances into maple shoots, by the roots or by stem injection, which would 'neutralise' the toxin. He found that diaminoazobenzene hydrochloride would do this—at least he reported reduction of disease symptoms, without any noticeable reduction in the vigour of the pathogen within the host. Since then work on 'antidoting toxins' has proceeded steadily at the Rhode Island and Connecticut Agricultural Experiment Stations and field-scale use has been reported, but the usefulness of the technique cannot yet be regarded as proven. Neither can such treatments be considered to be systemic fungicides in the true sense of the term.

Work in the U.S.A. and U.K.

Work is at present proceeding in the United States on the use of systemic fungicides for control of *Fusarium* wilts of tomatoes. Successful results have been reported by Dimond (1950). In this investigation plants were grown in sand or water culture and the roots treated with the compound under test ; the roots were then, after a suitable interval, washed, inoculated with the *Fusarium* and the plants grown on. Some treatments have given quite effective control of the disease and one is tempted to interpret such results as a systemic fungicidal effect, but as Keyworth (see Marsh, 1952) has pointed out, damage to the roots may result in resistance to infection by root pathogens. Keyworth has in fact shown that a simple heat treatment of the roots *before* infection is effective ; the reason for this peculiar effect is not known, possibly the damage to the roots so affects host metabolism that the plant is no longer a suitable substrate for the parasite.

In some respects more encouraging than any of the work described above are some results recently reported from two sources in England. Crowdy and Wain (1951), working at Long Ashton Research Station and Wye College, approached the problem with three points in mind—(1) that a systemic fungicide must not be phytotoxic, (2) that it must be readily trans-

located in the plant, and (3) that it must be inhibitory to fungi. They considered that ease of translocation might be the most difficult requirement to meet, so they decided to investigate the phenoxyacetic acid series. Several well-known selective weed-killers belonging to this series, such as 'Methoxone' and 2 : 4-D, and are known to be readily translocated in plants ; they are also mild fungicides. Crowdy and Wain sought to find whether it was possible to devise a molecular configuration which would not possess the specific plant growth-regulating activity of the herbicides but which would retain the ease of translocation and antifungal activity. They found that 2 : 4 : 6—trichlorphenoxyacetic acid approximately filled the requirements. Applied to broad bean plants through the roots it gave promising control of *Botrytis fabae* infection of the foliage.

Antibiotics

In all these researches one can infer from the protective effect observed that the substance applied is being translocated and acting as a fungicide in its new site. That inference is conceivably wrong and is certainly not sufficiently well supported by experimental evidence. We have already considered the possibility that application of the 'fungicide' may so alter host metabolism as to make it unsuitable for development of the pathogen. Another possibility is that in its passage through host tissues the substance applied may be metabolically altered, perhaps radically, leading to the formation of some other substance which exerts the final observed protective effect. Several workers have suggested that this may take place as systemic activity, by no means always highly correlated with *in vitro* fungicidal activity. In this connection results reported by Brian, Wright, Stubbs and Way (1951) are of interest. They worked with an antifungal antibiotic (produced by the common soil fungus *Penicillium nigricans*) known as griseofulvin (Brian, 1949). This substance disorganises growth of certain fungi, producing certain easily recognised and specific morphogenetic changes. By bioassay 0.1 microgram can be detected. They were able to show that if this substance was applied to the roots of plants growing in water-culture, sand culture or in soil, a substance could subsequently be detected in the tissues of stems and leaves possessing the same unusual properties ; this substance appearing in the stems and leaves is in all probability unchanged griseofulvin or some very closely related compound. Plants treated with griseofulvin showed little, if any damage. Good control of several plant diseases has been observed:—early blight of tomato (*Alternaria solani*), mildew of barley and oats (*Erysiphe graminis*), *Botrytis fabae* on broad beans and *Botrytis cinerea* on lettuce. Griseofulvin, unfortunately, is rapidly decomposed in soil by microbial activity.

Long term prospects

It is now clear that compounds with systemic fungicidal activity can be found. It is also clear that the great difficulty is going to be to find an effective compound which is harmless to the plant. The effective systemic fungicide, to a greater extent than is necessary with conventional fungicides, must be specific in its toxicity. No fungicides in use today are really specific in action. All are generally toxic substances and at high dosages are almost invariably phytotoxic ; fortunately the phytotoxic level is usually sufficiently greater than the effective fungicidal level to enable them to be used safely, but, as we have seen, the margin of safety is likely to be less with fungicides applied systemically. Specificity in fungicides must be based biochemically on specific interference with enzyme-catalyzed metabolic processes specific to fungi. Unfortunately, the more closely related two organisms are the more likely they are to possess similar enzyme complements. Thus for instance, fungi and higher plants being more closely related than insects and higher plants, it is likely to be much more difficult to find a specific systemic fungicide, harmless to plants, than to find a non-phytotoxic systemic insecticide. Moreover, our knowledge of fungus physiology is so exiguous that it is not possible at present to point to any metabolic processes which are specific to fungi and so afford starting-points for rational research on specific fungicidal activity. The nearest approach to a truly specific fungicide is the substance griseofulvin, mentioned above, which is believed to depend for its activity on interference with a growth-regulating mechanism specific to fungi (Brian, 1949).

Let us assume that this research will be successful. What then will be the advantages of a systemic fungicide? An answer to this question will at present necessarily be highly speculative, but perhaps of some interest. Four main advantages can be envisaged :—

(1) It may be expected that even application of the fungicide will not be essential, since parts missed at the time of application will be subsequently protected by translocation. In this connection it should be noted that almost all experimental work so far reported has been based on root treatment, as a matter of convenience. This would rarely be a suitable method of application in practice ; application to the foliage would be more practical but it is uncertain at present whether any of the known systemic fungicides can be effectively applied in this way. A particularly interesting possibility would be the protection of roots against soil-borne pathogens as a result of application of a systemic fungicide to the foliage. This would seem to be dependent on finding a systemic fungicide which can be translocated downwards through the phloem. Most of those so far investigated appear to travel mainly through the xylem and therefore most effectively upwards from root to shoot.

(2) Young growing parts, formed *after* an application of the fungicide, may be protected as a result of translocation. This may well be possible since such data as are at present available suggest that systemic fungicides do tend to accumulate in growing points. But, while growing points may thus be protected, it seems probable that this will be at the expense of older organs from which the fungicide has been withdrawn.

(3) It may be possible to obtain effective disease control under conditions of very heavy rainfall when conventional surface fungicides are rapidly leached away. Against this one needs to note that the protection afforded by systemic fungicides is not indefinitely prolonged, either as a result of dilution by distribution over newly formed host tissue or as a result of metabolic destruction of the fungicide in host cells. Neither must one forget that the rate of uptake of the fungicide by the plant will be almost certainly greatly affected by environmental conditions.

(4) It may be possible to control systemic diseases, such as the vascular wilts, which have proved so resistant to any means of treatment. The Panama disease of bananas (*Fusarium cubense*) is a notorious example of such a disease.

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(From the "Overseas Review" of Plant Protection, Ltd.).

CORRESPONDENCE

Jute Supplies

TO THE EDITOR

Sir,

I have read with considerable interest the articles in the February issue of WORLD CROPS on 'Kenaf in Mauritius' and would like to correct one misstatement in the introduction to the article. The first sentence ('*The shortage of jute has attracted attention to jute substitutes as a source of fibre for making bags.*') is based on facts and information that are about two years out of date.

In Pakistan, the main world source of raw jute, there was a surplus last season of 1,500,000 bales and the present season's crop has been a heavy one, estimated at 7,000,000. India has accumulated stocks of jute goods and in this country the supply position is now so satisfactory that all end use controls have been removed and consumers are free to trade as they did before the war.

The writer of the article is quite right when he says that shortages in 1947 (and he could have added 1948 and 1949 as well) created a bagging problem for the Mauritius sugar industry, but that statement could not be applied to the last two years or so, and is certainly not applicable at the present time.

Yours faithfully,
STANLEY W. SMITH,
Public Relations Officer.

The British Jute Trade
Federal Council,
64 Barrack Street,
Dundee.

Uganda Forestry Policy

TO THE EDITOR

Sir,

My attention has been drawn to an editorial in the October 1952 issue of WORLD CROPS on forest policy and native administration, in which severe criticism of the policy of the Uganda Government is made.

Professor Stebbing (in his review of the 1950 Annual Report of the Uganda Forest Department, which appeared in *Nature*) was obviously unaware of the conditions under which the handing over of forest areas to native administrations takes place. Adequate safeguards against abuse are provided, not only in the published forest policy statement of the Government, but also in the Forests Ordinance; I quote the relevant section of the Ordinance in full:

'7. (1) Every local authority shall maintain and control its local forest reserves in accordance with the advice of the Conservator.

'(2) When the Governor is of the opinion that it is expedient for ensuring the proper protection, control or management of a local forest reserve, he may, by order published in the Gazette, direct that such forest reserve shall be controlled by the Conservator and thereupon the Conservator shall exercise all the powers of the local authority over such reserve.'

The competence of a local authority to manage forest areas largely hinges on the availability of a competent forest staff; there is little incentive for the building up of this staff, unless responsibility for a forest estate does, in fact, exist. Considerable progress is being made in training this staff and meanwhile the Forest Department exercises an appropriate degree of control to ensure that no abuse of the forest estate takes place.

As these criticisms have received considerable publicity I have been requested to correct the misconceptions which have arisen.

Yours faithfully,
C. SWABEY,
Chief Conservator of Forests.

Department of Forestry,
Entebbe, Uganda.

The columns of WORLD CROPS are open to correspondence and the Editor welcomes letters from readers supplementing and commenting on articles or on other matters within our sphere. Limitations of space may necessitate the abridgement of letters.

Plain Words

TO THE EDITOR

My dear Sir,

I have hesitated a long time about writing you in connection with the spelling of the word 'fertilizer.' You spell the word with an *s*. In the United States and Canada the word is spelt with a *z*.

I have checked the authorities on the spelling of this word and apparently the Oxford University Press and the Cambridge University Press and the London *Times* newspaper spell the word with a *z*. The 'ize' is derived from the Greek, according to the authorities, and is the correct way of spelling the word.

Since one of the largest fertiliser manufacturers in Great Britain also spells the word with a *z*, why is it that you, as publisher of a magazine that is read throughout the world, persist in ignoring such usage by such a large part of the English-speaking world? It seems to me that you could be very helpful in removing the confusion by coming out forthrightly for the spelling which is approved by such British authorities as the London *Times*, the Oxford University Press and the Cambridge University Press.

I realise how difficult it is to break with certain traditions but this is one case where your highest authorities have set the standard and to follow their usage is in the best of your traditions.

Sincerely yours,
V. SAUCHELLI.

Baltimore 3, Maryland, U.S.A.
March 17, 1953.

THE EDITOR REPLIES

We appreciate Mr. Sauchelli's interest in and concern over the way in which we spell this word. The facts mentioned by him are indeed correct, but we venture to maintain that we still have a choice in the matter; our preference remains the use of *s* not only in the word 'fertiliser' but in other words having the alternative spelling, *e.g.* mechanise, utilise, etc.

The character *s* is, to our eyes, typographically more pleasing and less conspicuous (therefore less distracting) than the character *z*, and any disposition of printing material which, whatever the intention, has the effect of coming between the author and reader is wrong; that is a typographic fact.

After reading Mr. Sauchelli's letter we picked up the first six agricultural journals which happened to be in the office at the time. Three were published in the United Kingdom, one in Cyprus, one in New Zealand and one in South Africa. Each one spells fertiliser with an *s*, showing

WORLD CROPS

OUR NEXT ISSUE will include an account of the **Rice Industry in North Australia** and an article on **Aldrin and Dieldrin;** Part II of J. M. Beskine's article on **Rubber as a Raw Material in Agricultural Engineering** will also appear.

Cooperation and Integration in Oil Palm Research is the title of an article by S. de Blank, which will have an introduction by C. W. Wardlaw, Professor of Cryptogammic Botany at Manchester University.

Several additional articles will be included, as well as regular features (New Books, Farm Machinery, World Crop Reports, etc.).

that apparently we are not alone in our preference.

Sir Ernest Gowers, author of *Plain Words: A Guide to the Use of English* and the *A.B.C. of Plain Words*, both recently published books on the correct use of English, has this to say on the subject of -ise or -ize:

> On the question whether verbs like *organise* and nouns like *organisation* should be spelt with an *s* or a *z* the authorities differ. The O.E.D. favours universal *ize*, arguing that the suffix is always in its origin either Greek or Latin and in both languages it is spelt with a *z*. Other authorities, including most English printers, recommend universal *ise*. Fowler stands between these two opinions. He points out that the O.E.D.'s advice over-simplifies the problem, since there are some verbs (*e.g. advertise, comprise, despise, exercise* and *surmise*) which are never spelt *ize* in this country. On the other hand, he says, ' the difficulty of remembering which these *ise* verbs are is the only reason for making *ise* universal, and the sacrifice of significance for ease does not seem justified.' This austere conclusion will not recommend itself to everyone. It does not do so to the authors of the *A.B.C. of English Usage*, who say roundly, ' the advice given here is to end them all in *ise*,' a verdict with which we respectfully agree.

Tractor Training in Malaya

TO THE EDITOR

Sir,

I have to refer to your remarks in WORLD CROPS—Volume 5, No. 3, March 1953, page 122, ' Malaya Mechanises '—and would like to draw your attention to the fact that tractor training courses have been held at various centres in Perak ever since February 1952. These courses are under the joint auspices of the Department of Agriculture, Rural Industrial Development Authority and Borneo Motors.

Since that date such courses have been organised and no less than 200 students have attended and passed. The duration of each course is three weeks of intensive training.

The first Tractor-Training School in Malaya is in course of erection in Ipoh. This will be able to accommodate 50 students at a time and will be fully residential.

At the present time trainees from all over Malaya are attending the Perak courses. Many of the trainees are employed by the Rural Industrial Development Authority and the Department of Agriculture, but both estate owners and smallholders (Chinese and Malays) have taken advantage of the scheme.

Yours faithfully,

H. J. SIMPSON,
State Agricultural Officer.

Department of Agriculture,
Perak, Malaya.
March 31, 1953.

Hydraulic Lifts in Tractors

PRESENT AND FUTURE SCOPE OF HYDRAULICS DISCUSSED

AT a recent meeting of the Institution of British Agricultural Engineers, H. E. Ashfield, M.I.B.A.E., delivered a paper entitled ' Hydraulic Lifts in Modern Tractors ' which provoked one of the most interesting discussions in recent I.B.A.E. meetings.

The speaker opened his paper by differentiating between the two means of using hydraulic power, namely, one-directional internally built actuating mechanism, and the remote cylinder type actuated from the driver's seat. Either a two-way or one-way power cylinder can be employed in each case. On in-built lifts with a gravity return the hydraulic pump is usually driven from behind the clutch. Mr. Ashfield pointed out the disadvantages of this system in that, when the clutch is depressed, the system becomes inoperative. Where pump cylinders are used, it is desirable to run the pump direct from the engine at a point in front of the main clutch so that the hydraulic system is always in operation irrespective of the rest of the transmission.

Pumping systems

Gear type or reciprocated pumps are most commonly used today, the latter being considered to have the highest efficiency of the two corresponding pressures. Operating pressures vary between 1,000 lb. and 2,000 lb. per sq. in., *i.e.* the ***highest*** pressure reached before blowing the relief valve should be of this order. ' The choice lies,' said Mr. Ashfield, ' between a low pressure system simple to manufacture but using big quantities of oil to do a given amount of work and a small compact system using a small amount of oil but every part precision-made and using high grade material.'

He went on to discuss methods of sealing oil and different oil systems for transmission and power lift. The merits of the common oil system are cheapness and compactness, whereas the separate oil system allows the lift to be built not necessarily as an integral part of the machine.

Concluding, he said that the in-built lift in the body of the machine will be the most economical if the hydraulic lift is to be standard equipment on all tractors.

Discussion

During the discussion following the paper the speaker was asked a number of pertinent questions. When asked by Mr. Eric Alley whether it would be advantageous to have in general two-way rams on mounted equipment, he replied that in his opinion this system would not hold out great advantages, although two-way rams would be useful for trailing implements.

Referring to the question of single- or double-acting systems, Mr. Ashfield would not say that one was better than the other, but that they were complementary to each other, single rams for light work and double-acting systems for heavy work.

Asked whether there would be an extension of the fluid fly wheel, he said that this system does offer advantages although there may be transmission troubles, and there is some loss in performance which, although hardly noticeable on the large horse power tractor, would be apparent on the smaller machine. Introduction of the fluid fly wheel would also increase costs.

The importance of liaison between hydraulic designers and implement manufacturers was stressed when Mr. D. P. Ransome raised the question of the importance of there being enough oil in the tractor's sump to supply the hydraulic system's maximum requirements at peak load.

Mr. L. R. Bomford considered that the direct mounted plough was not so satisfactory as the trailed implement when one got to the three- or four-furrow class. The speaker agreed that the mounted four-furrow plough does become difficult to operate without the rear wheels of the tractor tending to sink into the ground, but for lighter ploughs he considered there was no question of their advantage, since they are manoeuvrable and much cheaper as a result of the considerably less weight of metal involved in their construction.

D. M. Walker made a plea for the hydraulically operated trailed implement which would, by its nature, be suitable for all makes of tractor. Mr. Ashfield replied that it was more economical to buy one make of tractor and the implements designed specially for it. A three-furrow trailer plough, he said, weighs about 12 cwt., compared with its mounted counterpart which is only about 8 cwt.

R. P. Morris mentioned the difficulties sometimes encountered in lowering the hydraulically-controlled implement such as an empty bucket, the weight of which may not be enough to bring it down in a short time, and asked about a device for catering with variations in load. In reply, the speaker said that the two-way ram system gives complete control either up or down; with the single ram the high pressure system is best.

RESEARCH DEVELOPMENTS

A Note on a New Quick Method of Propagation by Cuttings

The following note describes a method of propagating cuttings of tropical trees in which the plants are grown in a spray of water, thus ensuring continuously humid conditions. This method, we are informed, has also been used successfully in propagating cacao cuttings at the Imperial College of Tropical Agriculture in Trinidad. The author, Professor J. J. Ochse, is Professor of Applied Tropical Botany at Miami University; he was formerly for many years in charge of the horticultural division of the Ministry of Agriculture in Java.

Cuttings in the propagating bin showing the mist spray of water by which they are enveloped

In 1949 I published a preliminary report on a new method of raising cuttings of avocado and mango in the *Proceedings* of the Florida State Horticultural Society. Since then the method in question, which consists in propagating the cuttings under a continuous spray of water, has been developed in the southern part of Florida by many nurserymen with great success.

This method of propagation makes it possible to turn out plants more cheaply than ever before and with the use of a continuous spray of water nurserymen are able to put roots on almost any plant cutting within three to six weeks.

Details of the method

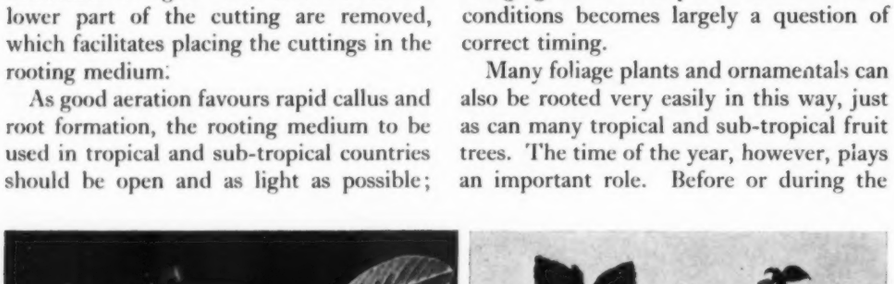
The cuttings are placed in a bin with their leaves intact, in full light, because photosynthesis takes place under optimum conditions of light. The leaves from the lower part of the cutting are removed, which facilitates placing the cuttings in the rooting medium.

As good aeration favours rapid callus and root formation, the rooting medium to be used in tropical and sub-tropical countries should be open and as light as possible; materials such as coarse sand, or crushed granite are best, but sandy loam can also be used.

The main difficulty after rooting is to get the rooted cutting to adapt itself to normal conditions without the constant spray. For that reason it is advisable to let the rooted cutting, after removal from the bin and transplantation to a pot, remain for a few days under the old conditions of spray, if possible, in a slat house, when bringing the rooted plants under normal conditions becomes largely a question of correct timing.

Many foliage plants and ornamentals can also be rooted very easily in this way, just as can many tropical and sub-tropical fruit trees. The time of the year, however, plays an important role. Before or during the dormancy period it is very difficult to get good results. The best time of the year is when young shoots start to develop; that is, in the tropics generally at the beginning of the rainy season. This method of reproduction may in the near future offer advantage for the propagation of rootstocks for perennials in the tropics and sub-tropics, and particularly for rootstocks resistant to certain diseases.

J. J. OCHSE.



(*Left*) **Cuttings raised by the spray method after four weeks.** (*Right*) **Cuttings of limes raised by the same method, six weeks old**

Technical News

'Tobacco Flavours' are the subject of an article by V. Vasie in the current issue of *Manufacturing Chemist*. Also included in this issue are an account of a new antibiotic factory in Sweden and progress reports on economic poisons.

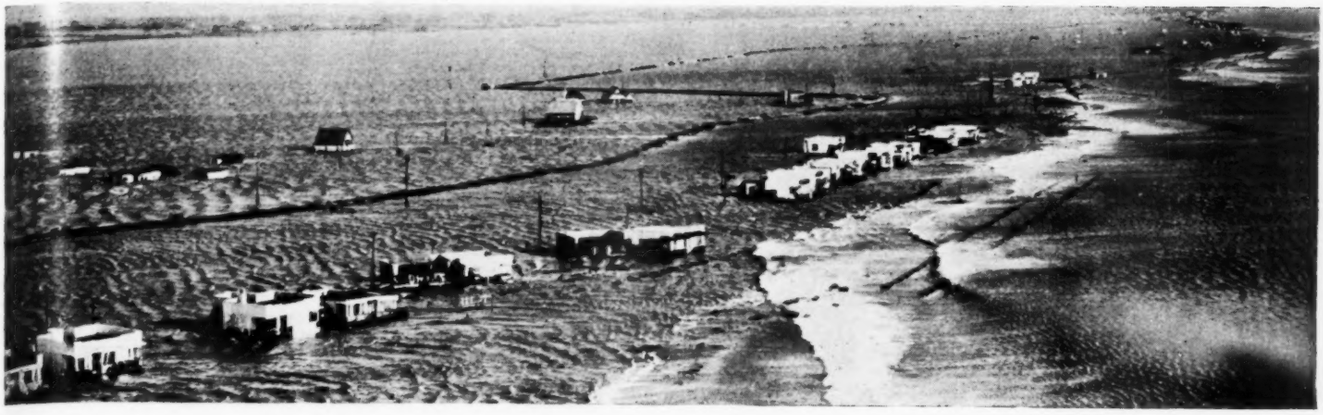
In *Chemical and Process Engineering* this month there is included an article on 'New Chemical Plant in Eastern Germany.'

Graham Savile continues his series of articles on 'Transport and the Food Industry' with Part IV in the May issue of *Food Manufacture*.

In *Fibres* (*Natural and Synthetic*) there is an article on 'The Crushing, Grinding and Disintegration of Fibres.'

A study of 'The Care and Maintenance of Grab Chains' appears in *Muck Shifter and Public Works Digest*.

Building Digest for May features an article on 'A New Neighbourhood in Mitcham.' In addition Nicolai Kolli writes on 'Aspects of the Soviet Architectural Style.' Also included will be an article on 'A Cigar Shaped Theatre in California.



A section of Jaywick Sands in Essex where chalets and bungalows were submerged by the January 31 floods

The Destruction Caused by the North Sea Floods

IN editorial comments in this and the preceding issue we have referred to the damage sustained, both in England and also elsewhere, as a result of the recent flood disasters.

We have since received from a correspondent in the Netherlands an appraisement of the damage resulting from the catastrophe in that country and this we reproduce below.

We have also received, through the courtesy of the Caterpillar Tractor Co., a series of photographs illustrating the damage in the inundated areas in England and some of the measures in progress to repair it. Four of these we reproduce on this page.

According to provisional data, the total area in the south-west of the Netherlands directly hit by the flood disaster is about 2,500 sq. km. (1,000 square miles), *i.e.* nearly 8% of the area of the Netherlands.

On January 1, 1952, the total population of these areas numbered about 581,000, *i.e.* more than 5½% of the Netherlands total population.

The number of persons who lost their lives as a result of the disaster is 1,750, while 66,000 persons had to be evacuated from the devastated area. About 133,000 hectares (325,000 acres) of farmland, *i.e.* 5·7% of the Netherlands total agricultural area, were inundated, comprising 82,000 hectares (200,000 acres) of arable land (8.9% of the total), 41,000 hectares (100,000 acres) of grassland (3.1% of the total) and 10,000 hectares (25,000 acres) of horticultural soil (9.4% of the total).

(*Top right*) **Muck was bulldozed to back up newly made concrete seawalls at Ingoldmills Point on the North Sea coast of England.** (*Centre*) **Bulldozers worked side by side to push sand and clay to the draglines for loading.** (*Bottom right*) **Caterpillar diesel crawler tractors pushed sand dunes back into position as protection against recurrent floods**

Proportionally pasture lands and the Netherlands cattle and dairy industries suffered to a small degree only.

The number of cattle in the flooded areas was well over 100,000, *i.e.* 3½% of the Netherlands stock. It is estimated that a quarter of this number drowned. Though this is a large number in itself, it is less than 1% of the whole Netherlands stock of horned cattle.

Nearly half the 40,000 pigs in the flooded area (2.2% of the total) were drowned and about 100,000 of the 380,000 fowls (1.6% of the Netherlands total). The numbers are certainly considerable, but their relative significance in Netherlands production is very small and the supply of Netherlands dairy produce (butter, cheese, condensed milk, milk powder), meat products (including bacon) and eggs to the world market is practically unaffected.

A more serious blow was dealt to Netherlands arable land, since in 1952 approximately a quarter of the total Netherlands wheat and barley crops, 30% of the peas and beans, etc., 18% of the potatoes for consumption and nearly 40% of the sugar beet came from the now inundated areas.

At the time of the disaster the greater part of the crops had already been removed and if the efforts to drive back the water meet with early success harvesting will still be possible this year and the fertility of the soil may be affected only to a slight extent.

Moreover, it is fortunate that the most important centres of horticultural production in Holland lie outside the devastated area.

It is of interest to record that the large enclosing dam of the Zuider Zee which was completed in 1932 resisted the storm magnificently. If this had succumbed the disaster would have assumed a greater proportion than it actually did.

It is considered that experience in this regard should be of value in making plans for the permanent protection of the area which has suffered from the present disaster. A commission has, it is reported, been set up to study the possibilities of amending the municipality of the Zealand by means of the dykes.

Typical of the havoc and destruction caused by the floods in Holland, this picture shows volunteer workers in the St. Maartensdijk area

NEW BOOKS

Grain Crops. 1952

A summary of figures of production and trade relating to wheat, wheat flour, maize, oats, barley, rye and rice. Compiled in the Intelligence Branch of the Commonwealth Economic Committee. Pp. xxiii + 144. H.M.S.O., 1953. 5s.

The admirable annual series of commodity reports has recently been augmented by the appearance of the summary, for the years 1951-52, of grain crops and, as usual, the publication is replete with reliable information and should be in the hands of all interested in questions of production and consumption of the essential cereals.

World production of grain has not kept pace with the increase in population since before the war, while the exportable surpluses of grains other than rice are becoming concentrated in fewer countries, mainly dollar countries. Production of wheat and maize, the two largest grain crops, has increased, but that of rice, the next largest, has shown little change. While the level of trade in grains in 1951 exceeded the pre-war average, the increase came largely from the expansion of shipments of wheat and flour; the level of rice exports continued low and rice-importing countries supplemented supplies by larger imports of wheat and flour or barley. With maize scarce, oats and barley constituted a large proportion of supplies of feeding stuffs to importing countries.

The increase in the production of wheat and coarse grains has come from areas no larger, and in some cases appreciably smaller, than before the war and is attributable to increased skill on the part of producers. Between 1934-40 and 1949-50 yields in the United States rose by proportions varying from one-fifth in the case of barley to two-thirds in the case of maize; Canada, Australia and a number of European countries, notably Denmark and the United Kingdom, have shown similar though less remarkable increases. The expansion in the total area under rice, however, has not been accompanied by a corresponding rise in production.

Changes in the levels of production and consumption in individual countries had affected the pattern of world trade in grains. Exports of wheat and flour were two-thirds greater by volume than before the war, due largely to increased shipments from North America.

But, although the proportion of the wheat crop exported rose over the period from 15% to 23%, maize was to an increasing extent used for home consumption, the proportion exported falling from 7% to 3%.

Oats and barley exports in 1951, although still a small proportion of total production, were almost twice those of pre-war years, but here, too, consisted to an increasing degree of shipments from North America. The increase in the world exports of these grains was, however, insufficient to offset the fall in maize exports. Although rice production had by 1948 again reached the pre-war level, the quantity entering world trade was limited by the reduced exportable surpluses of Asian countries and in 1951 amounted to little over one-half of the pre-war total.

Handbook of Agricultural Chemicals

By Lester W. Hanna. Pp. 209 + xv. L. W. Hanna, Forest Grove, Oregon, 1952. $3.0

'The agricultural chemical business is one of the large industries of the United States today . . . The great production of food and fibre crops is largely attributed to the scientific use of agricultural chemicals which have been developed, tested and manufactured by the greatest group of chemical companies in the world.' So says Mr. Hanna in the introduction to this handbook, which lists fertilisers, fumigants, fungicides, herbicides, insecticides and rodenticides.

There is no doubt that the American agricultural chemicals industry has grown tremendously during the last 15 years or so and produces more chemicals of this type than any other nation. Being a growing industry, it is still in a state of flux with research workers producing new organic chemicals in staggering succession; too quickly, in many cases, to enable really thorough trials to be carried out before they are put on the market. Other countries are experiencing the same state of affairs.

In producing this handbook Mr. Hanna has rendered a service to his country's agricultural industry by cataloguing and describing the agricultural chemicals that are available in that country, or were available in 1952. It is the type of book which will need regular revision and probably expansion to keep it up to date. As such it is doubtless a very useful reference book to the many people connected with agricultural chemicals in the U.S.A.

It is noticed that the systemic insecticides 'Pestox III' and 'Systox' are mentioned

in this handbook, the origin of the former being ascribed to ' a German chemist,' presumably Dr. Schrader, after whom the chemical is generally called ' Schradan.' The material has been used extensively by the British firm of Pest Control Ltd. According to Mr. Hanna's handbook, it has now been assigned to an American manufacturer.

Hanna's *Handbook of Agricultural Chemicals* should have an assured future in the U.S.A. and also, to a lesser extent, to the rest of the English-speaking world.

Advances in Agronomy

Vol. IV, edited by S. G. Norman. Pp. xi + 416. Academic Books Ltd., London and New York. $8.50.

This, the fourth volume of the series *Advances in Agronomy*, contains the following articles: ' Grassland Agronomy in Australia,' by H. C. Trumble; ' Types of Soil Colloid and the Mineral Nutrition of Plants,' by A. Mehrlich and N. T. Coleman; ' The Physiological Basis of Variation of Yield,' by Dr. J. Watson; ' Copper in Nutrition,' by F. A. Gilbert; ' Ecological and Physiological Factors in Compounding Forage Seeds Mixtures,' by R. E. Blaser, W. Skridla and T. J. Taylor; ' Soil Manganese in Relation to Plant Growth,' by E. G. Mulder and F. G. Gerretsen; ' Atomic Energy and the Plant Sciences,' by N. E. Tolbert and P. B. Pearson; ' Vegetation Control on Industrial Lands,' by K. C. Barrons; and ' Soil and the Growth of Forests,' by T. S. Coile.

The list of distinguished authors who have contributed reviews to this volume provides in itself an indication of its worth. As with previous volumes in this series, the range of subjects is vast, but the editor points out that agronomists ' sit on many stools and some face in different directions.' The standard of the reviews in this volume is probably higher than in any previous year, but improvements could often be made in both form and style.

Reviews are written in two different ways: some authors prepare a card index of all the available literature on the chosen subject, arrange the cards in a logical order and write the review from the ordered cards; others know the literature from extensive reading beforehand and write a review of the outstanding advances, making an appraisal of the work and using references only to papers which have made a real contribution to the subject. This second style of writing makes for reviews of greater value and much more interesting and stimulating reading. An excellent example is the review of grassland agronomy in Australia by Trumble, which is a very significant contribution to agronomic literature and is much more than the sum of the separate investigations which it reviews.

The critical discussion by Watson of the physiological basis of crop yields is valuable for the same reasons.

The advantages and disadvantages of an approach within narrow or wide limits are contrasted in the reviews of Australian grassland agronomy and ' Atomic Energy and the Plant Sciences.' The first sounds as if it is of provincial interest, but local grassland problems in Australia are reviewed in terms of grassland research in other continents. In fact, a special series of local problems is considered in relation to general aspects of world grassland. On the other hand, the review ' Atomic Energy and the Plant Sciences ' examines problems of world-wide interest with reference only to the work of the U.S.A. Atomic Energy Commission.

This is an indication of a general tendency in these volumes, that the more all-embracing the title the narrower in interest and approach is the review which it heads.

It is obviously impossible in a review of a volume of reviews to present a detailed appraisal of each article; it is perhaps sufficient to say that this volume will be useful to a considerable body of professional agronomists and that the assembly in it of reviews of so many apparently unrelated subjects should lead to an appreciation by specialists of the wide ramifications of agronomy as a science.

J. L. H.

To Authors and Readers

The Editor and publishers of WORLD CROPS will be glad to consider manuscripts of books submitted for publication. We already publish a number of books on technical subjects, all of which find a world sale, and most call for regular reprints and new editions.

Books of a non-fictional type in any language by any publisher can be supplied by the Book Department of WORLD CROPS.

Recent Publications by FAO

The Food and Agriculture Organisation of the United Nations have lately published a number of additions to their valuable series of development papers amongst which are the following:

No. 19. Community Organisation for Irrigation in the United States. The success of irrigation projects depends very largely upon the users of water having their own organisation. It is for this reason that this paper has been prepared. It is one of a series of papers published by FAO relating to the use of water for irrigation in various countries.

No. 20. Farm Management Investigations for Agricultural Improvement. Agricultural improvement depends very largely on improved management of individual farms, but improved management demands understanding of the problems of particular farms and intelligent application of good farm management principles. This paper is issued for the benefit of people generally interested in agricultural improvement. It illustrates at a popular level the uses, principles, facts and methods of management investigations.

No. 21. Some Aspects of Surface Water Development in Arid Regions. This is another in the series of papers on water use. Its object is to describe some of the methods successfully used in arid regions to develop the use of surface water supplies.

No. 22. Water Laws in Italy. This is yet another in the series of papers on water use. Its aim is to present in concise form the main features of the legislation affecting water use in Italy.

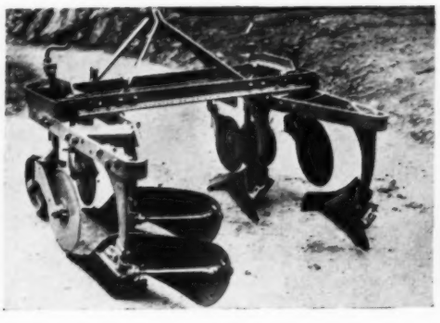
No. 23. Digest of Plant Quarantine Regulations. This is a digest of world legislation on plant quarantine; the original edition was first issued in 1949 and the present one brings this up to date. It is based on official documents and believed to be a true and accurate resume of the legislation at present in force.

No. 28. Cereal Breeding Procedures. This paper describes in considerable details the procedures adopted in manipulating and recording large populations in breeding work among the cereal crops, wheat, rice and other small grains. The author, Dr. J. B. Harrington, is head of the Field Husbandry Department of the University of Saskatchewan.

All these publications can be obtained from the official agents for FAO publications. In London these are H.M. Stationery Office, P.O. Box 569, London, and Leonard Hill Ltd., Stratford House, 9 Eden Street, N.W.1.

UNIVERSITY OF MICHIGAN LIBRARIES

FARM MACHINERY



(*Left*) **K.F.D. '52' with Acre Mark 11 rotary tiller** (*Centre*) **Stormont four-furrow 'in-out' plough** (*Right*) **K.F.D. '52' with seven-tine cultivator**

Narrow Gauge and Orchard Conversions of the New Fordson Major

Two conversions of the new Fordson Major tractor, a narrow 'hop garden' model and a low 'orchard' model, are now being made by the Stormont Engineering Co., of Tunbridge Wells, Kent, who are Ford main dealers.

The K.F.D. (for Kent Ford Dealers) Model '52' narrow-gauge conversion has been developed in conjunction with a four-furrow 'in-out' method of ploughing; normally speaking, narrow-gauge tractors have not up till now pulled anything bigger than two furrows. Overall width is 54 in. minimum with adjustable front and rear tracks; overall width of the standard model is 65 in. minimum. Turning circle is 21 ft. with steering brakes and 26 ft. without, the same as the standard model.

The export demand for this model is stated to be assured for cultivating vineyards, coffee and tea plantations.

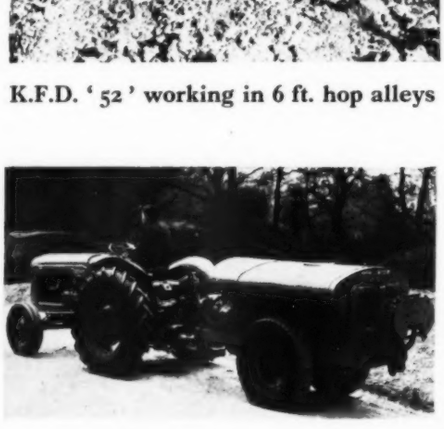
The Model '68' new Fordson Major with K.F.D. orchard conversion has been developed to meet the demand for a lower machine for operating in orchards, etc. Overall height to the top of the steering wheel is 57 in., compared with 63 in. on the standard model. Front axle design allows a turning circle of 17 ft. 9 in. with steering brakes or 22 ft. 9 in. without steering brakes.

All standard accessories supplied by the Ford Motor Co. will fit these tractors, with the exception of the hydraulic power lift on the Model '52,' which necessitates modified linkage and operating controls.

Prices of these models, hydraulic lift and special implements are as follows:

	£	s.	d.
K.F.D. Model '52' Fordson Major fitted diesel engine, complete with starter equipment	638	0	0
K.F.D. Model '68' Fordson Major fitted diesel engine, complete with starter equipment	585	0	0
Hydraulic lift and linkage (including P.T.O.) *extra* on both models	60	0	0
Stormont Four-Furrow 'In-Out' Hop Plough on Fordson toolbar with steel depth wheels	117	10	0
Stormont 7-Tine Hop Cultivator, complete with string guards on pneumatic depth wheels (including two spare tines)	43	0	0
Acre Mark II Tiller	54	6	3
Ransome Agro Low Volume Sprayer	546	0	0
Ransome Mounted Three-Unit Gang Mower	235	0	0

K.F.D. '52' working in 6 ft. hop alleys



K.F.D. '68' orchard conversion with Ransomes Agro low-volume hop sprayer

New Potato Harvester Operated by Tractor Driver

A new invention, claimed to be the answer to the potato harvesting problem, was recently put through its paces at a private demonstration. Named the 'Shotbolt' potato harvester, this machine separates potatoes from clods and haulm and cleans them before delivery to a trailer drawn alongside. The harvester requires only one man, the tractor driver.

The potatoes are dug in the normal manner of chain type diggers, power coming from the power take-off and depth being controlled by a screw adjustment accessible to the tractor driver. Having been lifted on to rod-link chains which are agitated the length of the normal chain digger, the potatoes, clods and stones are elevated on an extension of the same chain, which is not agitated, assisted by rubber flaps. A fan mounted on the front of the machine blows a stream of air through the potatoes, clods, stones and haulm, the latter being blown over a tank and on to a rubber-covered roller which deposits them in the ground at the back of the machine.

The potatoes, clods and stones pass through the air stream and drop into the shallow section of an L-shaped tank containing a suspension of earth in water having a specific gravity above that of a potato. In consequence, the potatoes float in the tank while the clods and stones sink to the bottom of the deep part of the tank after being swept along by rubber fingers across the tank and they are removed by a

rod-link elevator moving parallel with the potato rows and deposited on the ground.

The floating potatoes are passed on to an elevator which transports them into a trailer. While on this elevator, the bottom of which is in the separating tank, they are sprayed with clean water, carried in an 80-gal. tank on the machine and pumped to the spray nozzle at a pressure of 40 lb./sq. in. This amount is calculated to carry round a field 20 chains long under the worst conditions that it would be possible to work a potato harvester.

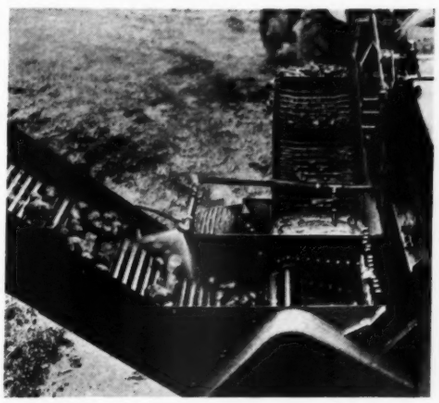
It is stated that the capacity of the machine varies from two to six acres per day, according to conditions. The potatoes arrive in the trailer in a comparatively clean condition, free from loose soil, clods or stones, and are surface wet after their 4 sec. immersion in water. Private tests carried out on clamped potatoes have shown the potatoes to be dry in 10 days.

The manufacturers of the 'Shotbolt' harvester, the Catchpole Engineering Co. Ltd., are producing a limited number of these machines this year and state that the price will be made known in June.

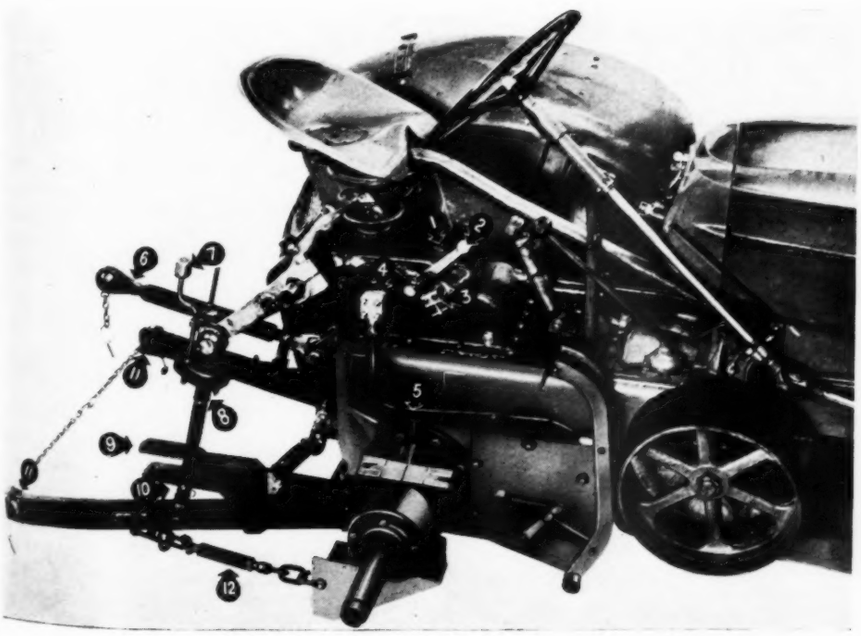
The Catchpole Engineering Co. are already well known for their work on the mechanisation of the sugar beet crop; in fact, they claim that in 1951 nearly half of the 74,241 acres of sugar beet in the U.K. which were mechanically harvested were lifted by Catchpole machines. Overseas these harvesters are operating in France, Belgium, Holland, Austria, Sweden, Israel, Canada, Uruguay and Italy.

The company are building a new factory at Bury St. Edmunds, as a result of increased production, and it is hoped to occupy the new premises by the end of January.

Shotbolt potato harvester, manufactured by the Catchpole Engineering Co.



Potatoes are spray-washed before leaving the harvester



Massey-Harris 744 diesel tractor, with right-hand rear wheel removed, to show features of the hydraulic lift. 1. Jack-tapping point for remote rams. 2. Lift lever. 3. Depth-control stop. 4. Oil reservoir. 5. Pipe leading from pump to reservoir. 6. Centre-link—ball-and-socket joints at either end. 7. Screw-thread levelling control. 8. Screw-thread adjustment on lift-arm. 9. Drawbar hitch. 10. Pin-and-holes adjustment on lift-arm. 11. Lower draught links. 12. Sway chains

Hydraulic Lift for Massey-Harris 744D

The Massey-Harris diesel tractor, No. 744D, is now available with a new hydraulic lift capable of a lift of 2,500 lb. at the end of the draught links. With three-point linkage to British Standard category two, the lift can also be fitted with slave rams and hose couplings for trailed implements and, in addition, arms can be supplied for forward-mounted tools. A feature of this new lift is its direct operation from the drive shaft independent of clutch action. In addition to rear-mounted implements, Massey-Harris hydraulics will raise trailed implements by means of a slave ram mounted on the implement itself and coupled to the hydraulic box underneath the tractor seat.

The valve unit on the new lift controls the linkage by means of one lever which is pushed forward to lower and back to lift. Mounted implements can be lowered at two speeds to operate at a constant depth, which can be varied by the 'lowering control stop' on the valve unit. Lift arms can be held firmly at any point. Further variations to the depth of working can be made by adjusting the lift arms on the draught links. A screw thread levelling control on

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the right-hand lift-arm adjusts the plough to keep it squarely in the ground.

The pump delivers 5¾gal./min at 1,350 r.p.m., speed being governed by the r.p.m. of the engine. It is fitted behind the radiator and driven from the forward end of the engine crankshaft through a flexible coupling. A starter dog on the outer side of the pump enables the engine to be turned over by the starter handle. The relief valve in the system is set at 2,000 lb./sq. in. and pump pressure will build up until this figure is reached.

Massey-Harris Ltd. state that the hydraulic lift may be fitted to all models of the 744D rowcrop and is available as extra-order equipment costing, with three-point linkage, £85.

New Pressure Retaining Knapsack

Two new models of the 'Mistifier' pressure-retaining knapsack are announced by the manufacturers, Messrs. Drake and Fletcher Ltd., of Maidstone, Kent; they are the Model 25, 2½-gal. liquid capacity, and the Model 35, 3½-gal. liquid capacity.

New patented features include a replaceable lining in the form of a collapsible bag, ensuring that the spray liquid is never in contact with the canister.

As a result of the patented bag arrangement, every scrap of liquid is expelled and, the makers claim, this increases actual spraying time by 5% over pneumatic machines of any other make and allows the canister to be completely washed out after spraying hormone weed-killers or other liquids which can be harmful if traces are left in. Also the liquid cannot form crystals and block up the pressure gauge or the relief valve.

Air can be retained in the machine almost indefinitely and pumping is wholly eliminated.

New model of the 'Mistifier' pressure-retaining knapsack sprayer

30 Tractors Clear 39,000 Acres of Khans Grass

A team of 15 International TD-24 crawler tractors ploughing khans grass in Central India as part of the programme of the Government's Central Tractor Organisation recently turned in the record performance among 16 clearing teams employed.

During the 1952 season, extending from January to June, CTO Tractor Unit No. 13 cleared more than 20,000 acres of the jungle-like grass in the drive to reclaim land for food production and is reported to have been the only team to exceed its seasonal quota. Another team also operating with TD-24s ranked second with 19,200 acres. Both units were employed in ploughing at a depth of 16 to 20 in.

The CTO project was inaugurated in 1947 as part of the Government's 'Grow More Food' campaign to rehabilitate approximately 10,000,000 acres in Central India infested with the strangling weed. More than 700,000 acres have been cleared.

The 30 International crawlers comprising the two most productive ploughing teams are part of more than 240 tractors of all makes at present employed on the project.

Included in the first consignment of supplies from Australia to Pakistan under provisions of the Colombo plan were 15 McCormick International model AW-6 wheel tractors to the Punjab Government Irrigation Department for use in the construction of canal links and other irrigation projects

Award for Disc Plough

Messrs. Kenneth Hudson & Son announce that their three-disc plough was awarded a silver medal as an implement of outstanding merit during the national ploughing championships recently held at Mullingar, Northern Ireland.

PEOPLE IN THE NEWS

Prof. T. Wallace

Readers of WORLD CROPS will have learned with interest that among the recently announced list of new Fellows of the Royal Society there appeared the name of Professor T. Wallace, C.B.E., Director of Long Ashton Experimental Station. Professor Wallace's name is known the world over by reason of his researches on the so-called trace elements in plant nutrition, and all will agree that the election is a well-deserved recognition of his eminent services to the cause of agricultural research.

Rotary Hoes' Indian Representative

Mr. M. L. Mehta has been appointed factory representative of Rotary Hoes Ltd. in India.

Before partition Mr. Mehta was Director of Land Reclamation for the joint Punjab and subsequently became Director of Rural Rehabilitation in East Punjab.

In 1949 he re-formed the Land Reclamation Department in East Punjab, whose job was to reclaim waterlogged and salt lands and to initiate soil surveys in connection with irrigation projects.

In 1952 Mr. Mehta became the land reclamation consultant of the Ministry of Irrigation and Power of the Government of India. His appointment with Rotary Hoes takes effect from May 1, 1953.

New European Representative

Rotary Hoes Ltd. also announce the appointment of Mr. Oscar Maultasch as their factory representative for Europe (including Scandinavia) and the Near East. They state that Mr. Maultasch can claim many years' experience in the agricultural machinery trade and has excellent first-hand knowledge of practically every country in Europe and the Middle East.

16,558 Howard Rotavators were despatched from Rotary Hoes Ltd. during 1952. Of this total, over 11,000 were exported and were shipped to 77 different countries.

PARIS MACHINERY SHOW

(From a Correspondent)

THE French International Agricultural Machinery Exhibition (Salon International de la Machine Agricole), which celebrated its silver jubilee during March (10-15), 1953, at the Porte de Versailles, Paris—it was first held at the Grand Palais in 1922 but lapsed during the German Occupation—was visited by 250,000 people in six days. Its 125 acres, which comprised five large exhibition halls, and a vast outdoor area, could only be toured in comfort by using one of a fleet of small electrocars. There were 860 exhibitors from 16 different countries, showing every make of tractor, harvester and agricultural implement, and next to France with 600 exhibits and Germany with 78, the British section was the third largest with 37 as against 57 last year.

France is an agricultural country, for every third Frenchman still works on the land, but travelling to Paris on the pleasant Newhaven-Dieppe route through the fertile Normandy fields, the granary of Northern France, the visitor sees hardly a tractor and hundreds of teams of horses doing the spring ploughing.

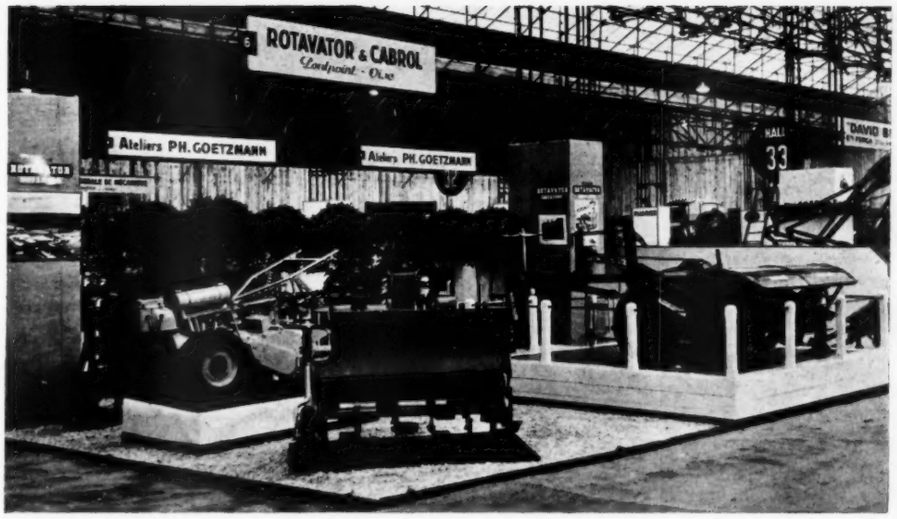
France mechanises

How is it then that this truly international Agricultural Machinery Exhibition is held in Paris and gets over four times the attendance of the Smithfield Show, which was visited by 59,000 last year? The reason lies in the fact that France is only just beginning to wake up to the fact that farm mechanisation is the only practical solution to increased food production. Before the war there was always great reluctance on the part of French farmers to mechanise. Labour was cheap, heavy horses were preferable because they provided manure as well as power and when worn out could be sold.

Post-war years brought a rapid change. Rising wages, the lure of shorter working hours in the factories of Lille and Lyons, proved too great a temptation for farm labourers and decided many a 'patron' to buy a tractor, especially when the government guaranteed stable prices for food produce.

Tractor requirements

The lesson of this year's Paris Show is that if Britain wishes to retain her export to France production must be adapted to suit the French. Their farms are smaller than ours and consequently they prefer a medium tractor of 15-28 h.p. to the heavier type of machine. In 1939 only 25,000 tractors were in use; today there



One of the stands exhibiting a British product at the Salon International de la Machine Agricole

are 200,000, but whereas in 1951 Britain supplied about 60% of the demand this has now fallen to 15%. French manufacturers now produce no less than 84 makes of tractor. Renault, whose works are now nationalised, have lost the lead during the past year to the French branch of Massey-Harris. Ferguson is still the most popular British make and will shortly be produced by the Hotchkiss Works at St. Benis-sur-Seine to overcome mounting import restrictions.

Small tractors and motor cultivators, such as the Ransome MG5 and the Howard Rotavator, are still predominantly British. They suit the French market gardener, wine grower, and last but not least the farming monastery or convent.

Fordson of Detroit have been quick off the mark to meet this increasing demand for the medium tractor. Their new A.A.N. 'Fordson Minor' has 28 h.p. and costs only Frs. 750,000 (£750), less than the Ferguson at Frs. 850,000 (£850), and they could sell ten times more than their present weekly output which is only 800. S.F.V. (Societe Francaise Vierzon) have also brought out a new smaller tractor, the S.F.V.201, which is semi-diesel, has 22 h.p., and costs Frs. 1,095,000 (£1,095).

Machines Nouvelles

No gold medals are awarded at the Salon in Paris, but a jury of ten agricultural engineers annually awards the distinction 'Machine Nouvelle' to what they consider outstanding new developments. Among these was a 'Grasscracker' made in the U.S.A. which breaks down the fibres of tough grasses, making them more easily digestible. Its price, however (Frs. 850,000 (£850)), makes it too dear for the French. Two 'machines nouvelle' of French make were a tractor-mounted manure lifter with telescopic swivel arm, costing Frs. 490,000, and a four-wheel tip-trailer available in three different sizes for four, six and eight tons, with prices ranging from £410 to £625. Another French machine was a new self-propelled combined harvester-thresher, convertible into a pick-up baler. At Frs. 3,200,000 (£3,200) it will only interest the agricultural contractor. A new pick-up baler made by an Orleans firm is claimed to work at a higher density than anything so far produced and will be shown at the Royal Show at Blackpool this year; this costs Frs. 1,150,000 (£1,150).

Although import licences make it more and more difficult for some machines to be shown and sold—for instance, the stand of the Catchpole Sugar Beet Harvesters remained empty, because their licence was not granted—highly specialised machinery such as feather pluckers for poultry, or egg-grading machines are selling well, simply because the French have nothing to offer in that line. One firm reported to have been doing excellent business were J. W. & T. Connolly Ltd., whose Trailer Tracks without link pin or bushes sell well at Frs. 234,265 (£235), and so does their Pentagon Hub Equipment with cranked arms of forged steel which costs only Frs. 26,275 (£27) complete with import duty.

The French are well ahead in the field of soilless cultivation. A six-tier germinating cabinet costing £1,350 can produce green fodder for 40 cows in midwinter from any seed without soil in six days.

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WORLD CROP REPORTS

PAKISTAN

Cotton crop prospects. The third forecast of the area under cotton for the year 1952-53 is 3,320,000 acres (American varieties 2,896,000 acres and Desi varieties 424,000 acres). The increase in respect of American and Desi varieties is 8.0% and 15.8%, respectively.

The yield of the crop is estimated at 1,344,000 bales of 392 lb. each (American varieties 1,188,000 bales and Desi varieties 156,000 bales). The increase in respect of American varieties is 8.9% and in respect of Desi varieties is 11.4%.

These figures are subject to revision in the light of information awaited from Khairpur State.

Total exports of raw cotton from Pakistan for the first six months of this season (September 1952 to February 1953) have exceeded 800,000 bales and can be counted as a very satisfactory performance. Outstanding sales on export account for March/April shipments are estimated to be about 1¼ to 1½ lakh bales.

By March 1, 1953, the entire stock of old cotton crop held by the Government-sponsored Cotton Board had been cleared through barter deals. With the final transaction involving the sale of 9,000 bales to Italy, Pakistan had exchanged one lakh bales of old cotton crop for cotton yarn with Italy, Hongkong and the Lebanon.

The Pakistan Government are now considering offers that have been received for the exchange of new crop cotton for wheat.

MADAGASCAR

Spice production, 1952. Clove production in Madagascar in 1952, according to R. F. Andrews, American Consulate, Tananarive, was about 250 metric tons. In the three-year cycle of the clove tree 1952 was the bad year and, to make matters worse, heavy rains during the flowering season caused considerable damage. The 1953 year is expected to be a year of peak production, with estimates ranging from five to seven thousand metric tons.

Vanilla production in Madagascar in 1952 was estimated at 200 metric tons; however, since prices are high, temptation to increase production will be strong.

Pepper production in 1952 was about 400 metric tons. French reliance on Madagascar pepper has increased since French Indo-China production has been falling off. Production for 1953 is estimated at 450 metric tons and should increased plantings continue by 1956 production should rise markedly.

U.S.A.

Prospective plantings for 1953. The Crop Reporting Board of the United States Department of Agriculture makes the following report on the indicated acreages of certain crops in 1953, based upon reports from farmers in all parts of the country to the Department on or about March 1 regarding their acreage plans for the 1953 season.

The acreages actually planted in 1953 may turn out to be larger or smaller than the indicated acreages here shown, by reason of weather conditions, the agricultural programme, and the effect of this report itself upon farmers' actions.

PLANTED ACREAGES
('000 acres)

	Indicated for 1953	1952	1951	*Average 1941-50*
Maize	81,800	82,658	83,283	88,379
All spring wheat	21,600	21,518	22,264	18,742
Durum wheat ..	2,100	2,306	2,586	2,644
Other spring wheats ..	19,500	19,212	19,678	16,098
Oats	43,800	42,975	41,682	43,968
Barley	9,400	9,385	10,869	13,986
Linseed ..	4,100	3,450	4,116	4,283
Soybeans ..	15,900	15,457	14,838	12,788

FIJI

Copra production. Copra production in 1952 was a record for the Colony, the total amounting to 40,262 tons, an increase of 4,430 tons over the previous record of 35,832 tons in 1951.

VENEZUELA

Sesame estimate. Venezuela's 1952-53 sesame crop is estimated at 4,400 short tons, half of which was produced on the Paraguana Peninsula. The Paraguana Peninsula is the locality where sesame is harvested by machete. In Portuguesa the planting of sesame is mechanised and the crop is usually harvested with modified wheat binders. In 1951 sesame production in Venezuela amounted to about 3,300 tons.

SOUTHERN RHODESIA

Record tobacco crop anticipated. A statement issued on February 12 by the Rhodesia Tobacco Association suggests that the 1950 record of 104,500,000 lb. of flue-cured tobacco will be exceeded this year, although the persistent overcast weather and intermittent heavy rain of recent weeks has tended to reduce the weight of the crop. In the middle of January there was every chance that the total crop would be at least 125,000,000 lb. and that the average quality would be higher than ever before. Some excellent tobacco from early plantings has already been cured, but later plantings have suffered from lack of sunshine, and in many cases plants have ripened too quickly for the existing barn accommodation. Compensation for hail damage this year is expected to exceed £100,000.

JAPAN

Sugar beet. The 1952-53 beet sugar campaign has yielded 31,790 metric tons which compares with a previous estimate of 27,795 tons and an output in 1951-52 of 25,622 tons. In the pre-war year 1938-39 the production was 44,383 tons.

(*From Czarnikow's 'Sugar.'*)

ENGLAND AND WALES

1952 crop returns. The estimated yields per acre of corn crops in England and Wales in 1952 were higher than in the previous year, except in the case of barley, and all were above the average of the preceding 10 years. The total production of wheat declined by 19,000 tons (1%) owing to the smaller area sown, but an increase in the acreage of oats, together with a higher yield per acre, resulted in an increase of 101,000 tons (7%). The considerably larger area under barley more than offset the effect of the decreased yield per acre and production increased by 318,000 tons (18%).

The yield per acre of potatoes in 1952 was again well above average, but the reduction in acreage accounted for a decline of 368,000 tons (6%) in total production compared with the previous year. The production of sugar beet fell by 298,000 tons (7%), while the total production of other root crops fell by 635,000 tons (6%).

BRITISH HONDURAS

Ramie shipments. In November 1952 the Colonial Development Corporation made the first shipment of ramie fibre grown on their Barton Ramie Estate, which was opened up for cultivation two years ago. By the end of January 1953 some 21 tons of the fibre had been exported, the total value of which amounted to $BH 14,344 (£3,586).

JAVA

Rice output from Central Java in 1952 totalled 25,800,000 quintals, compared with 23,900,000 quintals in 1951. There are 1,065,000 hectares of rice fields in Central Java, including 300,000 hectares planted with Solo River rice. It is expected that output in 1953 will be 10% higher than in 1952, as a result of irrigation under the special welfare plan.